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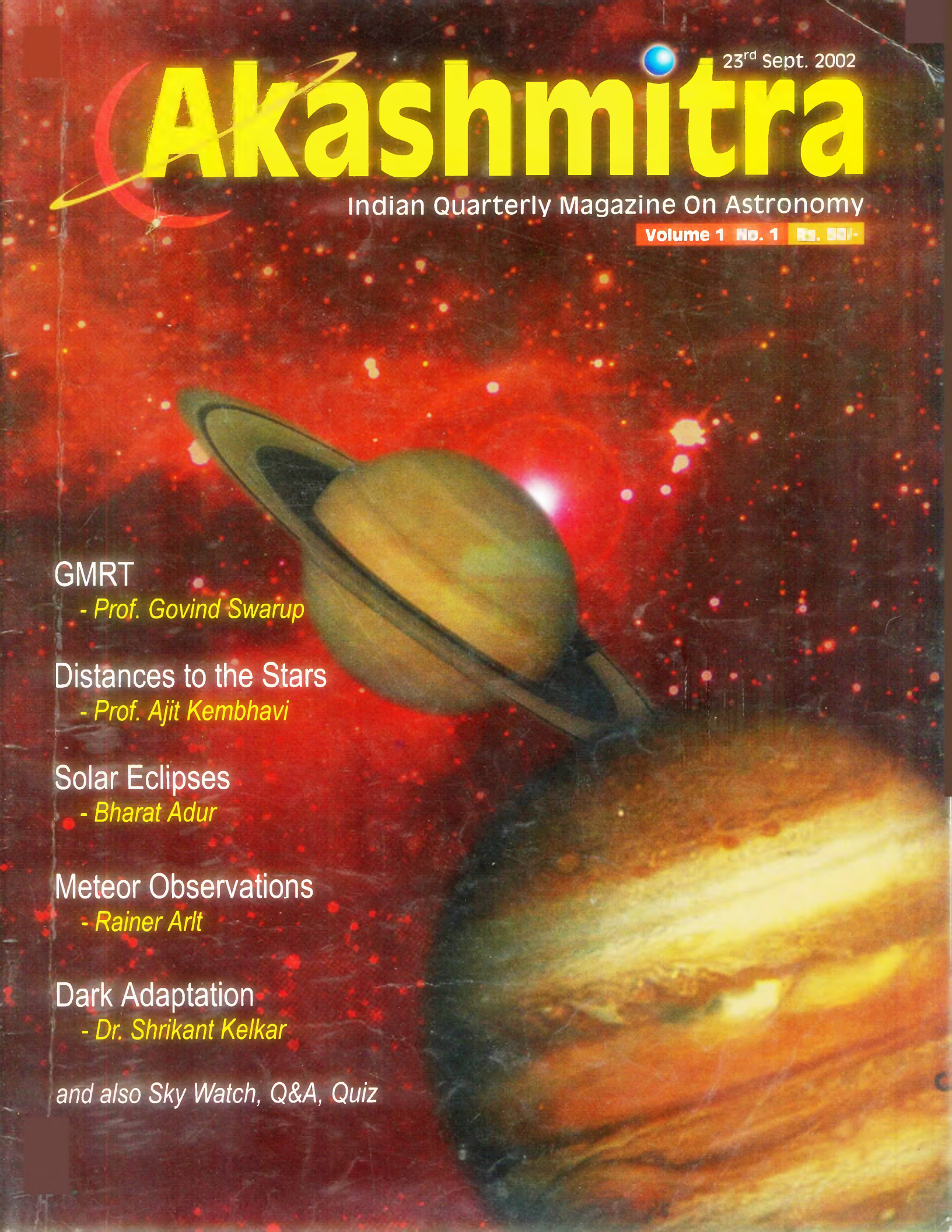

GMRT
- *Prof. Govind Swarup*

Distances to the Stars
- *Prof. Ajit Kembhavi*

Solar Eclipses
- *Bharat Adur*

Meteor Observations
- *Rainer Arlt*

Dark Adaptation
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and also Sky Watch, Q&A, Quiz

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by *N. Murugan*, Chennai, India

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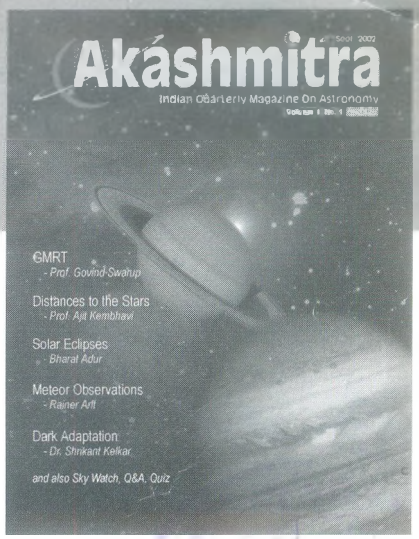

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- Dr. P. S. Shiralkar
- Mrs./Mr. M. V. Apte
- Mrs. Manjri Mahabal

This issue is dedicated to

Manali Kallat Vainu Bappu

1927 - 1982

The first astronomer after **Mahraja Sawai Jai Singh** (18th century)
to build major astronomical observational facilities in India.
He was the Founder Director of the Indian Institute of Astrophysics.

(See page 1 for full article)

Editorial

Dear Readers,

It gives us great pleasure to bring out this first issue of Akashmitra, a magazine on Astronomy. The magazine will be published every three months, coinciding with the equinoxes and solstices.

Astronomy is one of the sciences in which an individual interested in it as a hobby can make his own significant contribution. We Indians, have always been fascinated by the sky. The amateur astronomers have longed for an Indian Astronomical magazine of international standard at an affordable price reaching out to all those in quest of knowledge of the universe.

Our plan is to make this magazine reader-friendly and interactive. Apart from being affordable it will be rich in content – Articles on Indian Astronomers, contribution by eminent astronomers and scientists; information about forthcoming celestial events, astronomical photography, all about telescopes , quiz and much more to quench your thirst for knowledge. You may also find here information through classified ads about buy and sale of articles, exchange etc. to promote your astronomical hobby.

Space exploration began in 1957, when the first artificial satellite was launched. The development of space travel has provided information about our solar system. As such, space exploration will also find a place in our magazine.

We seek your constructive criticism and invite your valuable suggestions. We do not have any previous knowledge or experience of running a magazine , it is our love towards the subject which has prompted us to do it. So, if some inadvertent errors have found their way on these pages, do not spare us,

Akashmitra owes its existence to Dr Shreekant Kelkar (Director - National Institute of Ophthalmology, Pune), Mrs. Aruna Kelkar, & Drs Sangeeta & Aditya Ponkshe. It is due to their untiring efforts & constant support that this magazine is out today.

Arvind Paranjpye

Editor

We welcome your contributions in the form of :

Articles

Photographs

Club Activities

Astronomical Observations

E-mail : editor@akashmitra.com

The Indian Institute Of Astrophysics

Since its inception in 1972, the Institute has made significant contribution to A & A

D. C. V. Mallik
Indian Institute of Astrophysics

Beginnings

In June 1972, the name of a sleepy little village, hidden in the depths of the sandalwood forests in the Javadi Hills of Tamil Nadu, received sudden attention in international press, for close to it in an observatory that bore its name, astronomers of the Indian Institute of Astrophysics had just then carried out an important observation which, for the first time, gave an indication of the existence of an atmosphere in the Jovian satellite Ganymede. We shall never know if the villagers ever got to know of this sudden leap to fame of their village, although some of their kith and kin had probably already been associated with the observatory in some activity or the other - tending its gardens, maintaining its newly built buildings, keeping watch at its imposing gate or cooking meals for the astronomers. For the astronomers of the newly created Indian Institute of Astrophysics it was a fulfilling experience as it was perhaps the first significant use they made of their newly acquired 102 cm Zeiss telescope.

It was just over a year ago that The Observatory at Kodaikanal was reborn as an autonomous institution freed from the stifling hold of the Indian Meteorological Department. The newly christened IIA inherited at birth the rich traditions of astronomical research from its parent. The Observatory at Kodaikanal functioned since 1899. Its parent was the Madras Observatory established by William Petrie in 1786.

By the standards of the 1960s and from the point of view of stellar observations, the facilities in Kodaikanal left a lot to be desired. The sky conditions permitted only a few clear observing nights during a year. The largest telescope was a mere 51 cm reflector and the focal plane instruments were primitive. No serious astronomer would have been contented with the prevailing situation, nor was M. K. Vainu Bappu, the young and dynamic director of the observatory who assumed charge in 1960 at the relatively young age of 33. Needs of the handful of stellar astronomers that Bappu gathered around him had far outgrown the telescopes and the equipment available. It was clear that if Optical Astronomy were to survive and thrive in India, radical measures were required.

As early as 1962, Bappu had started the search for a good astronomical site in peninsular India where a stellar observatory could be built. A decade-long effort led him finally to the spot in Javadi Hills where the Vainu Bappu Observatory stands today.

Stellar observations started in Kavalur in 1968 nearly three years before the formal creation of IIA. A 38 cm telescope housed in a roll-off shelter was the first instrument in operation. Situated at a latitude of 12 34'.6 N, a telescope in Kavalur can peer into the southern skies, . an ability which was to work to its special advantage years later in 1987 when it was perhaps the only observatory in the northern hemisphere to take spectra of SN

1987A. The 102 cm Zeiss reflector arrived in crates in March 1969 and the team of German Engineers arrived in January 1972 to instal it. The telescope started operating in May 1972 and within a month made its presence felt with a successful observation of the occultation of SAO 186800 by Ganymede. The talk of a much larger telescope, one of 2-m class, was already in the air. Although it was not yet certain that the large telescope would also be installed in Kavalur, the air was thick with expectation. It was only in 1976 that the IIA Council finally approved the location of the large telescope in Kavalur. Kavalur was poised to take off as a major observatory. It has been the main seat of observational work in IIA.

Maturity

Kavalur Observatory formally attained maturity in January 1986 when the then Prime Minister of India, Rajiv Gandhi inaugurated its 234 cm telescope and named the telescope and the observatory after its creator, M. K. Vainu Bappu. Rajiv Gandhi's visit to Kavalur was dictated by an astronomical event-the appearance of Comet Halley on its second sojourn to the solar vicinity in this century. The youthful and scientifically aware Prime Minister wanted to have a good look at this celestial wonder and expressed a desire to visit Kavalur. M. G. K. Menon, Chairman of the IIA Council, seized the opportunity to convert the PM's visit into a gala affair of commemoration. The 234 cm telescope, Bappu's dream project, was nearly fully ready. The first photograph with it was already taken in November 1985, therefore, in the fitness of things that the Prime Minister's maiden visit was utilized appropriately to have the telescope formally inaugurated. Eye-witness accounts suggest that the Prime Minister thoroughly enjoyed his visit to Kavalur. He even climbed into the prime focus cage of the large telescope and peered into the dark skies with singular satisfaction. Comet Halley eluded him though. Instead Gandhi saw the more permanent celestial wonders like the Orion Nebula and Jupiter and its moons.

By the mid-eighties the observatory had already produced a substantial amount of work with its smaller telescopes. In March 1977 it had participated in the Uranian occultation experiment and was one of the small group that was responsible for the discovery of the rings around the green planet. A number of PhD dissertations had been completed and several more were in progress. The number of astronomers had grown from less than a dozen in 1972 to more than twenty in 1985. Astronomers, whose research life had started with the establishment of the Kavalur Observatory, matured along with it and they were now leaders of groups, while a younger generation was being inducted into active astronomical research. Bappu never lived to see these developments. He died in August 1982 due to complications following a heart by-pass surgery.

In January 1996 the Vainu Bappu Telescope completed ten years of its formal existence. It has been operated as a National Facility. It attracts proposals from all over the country and sometimes from outside India. But the needs of the IIA astronomers have already outgrown this telescope and the facilities at VBO. Demands of their science have taken them far and wide to telescopes in Australia, Chile and the United States. They have also used space-based facilities like the IUE and data from IRAS and EXOSAT to pursue their specialized interest. Today there is hardly an area of observational astronomy that is neglected by the astronomers in IIA.

Astronomy has also changed in many ways and the perceptions of the sixties and seventies are no

longer very relevant today. In this era of globalization and of accessibility to data through network and information transfer, an astronomer is able to collect data from anywhere in the world sitting at his/her desk. A lot of data from spacebased facilities becomes available in the public domain after a stipulated period of time and these can be used to produce quality science. The needs of an astronomer have thus become somewhat different and so has his use.

The skies in Kavalur have not been very encouraging either. The number of clear photometric nights is rather small in a year and the total number of observing hours per year is about two-thirds of a world-class astronomical site. Kavalur is hit by two monsoons and hardly any observation is possible at VBO between the months of May and December. VBO is also located at a low altitude by the standards of major observatories and it is hardly sufficient for any kind of infrared work, an area of astronomy that is becoming more and more important and popular. The astronomers in IIA have felt the need of a large telescope in a better site where uninterrupted observations will be possible. With the commissioning of a large number of large telescopes in the southern hemisphere, the reason for having an observatory in peninsular India, to capitalize on the observation of the southern skies, is no longer applicable. With all this in mind, IIA is currently pooling in its resources to set up an observatory in the wilds of Ladakh close to the Tibetan border, where the skies are clear for a larger fraction of the year and where infrared astronomy should be possible, as the region is known to be amongst the driest in the world. The current plans are to put a 2-m telescope there during the next couple of years. The new observatory in Hanle will not diminish the importance of VBO in any way. It will complement the efforts at VBO to have better Spectral and temporal coverage of celestial phenomena. The harsh weather conditions there will require that the bulk of the observations are carried out in a remote mode and commands from the observer to the telescope and the acquired data from the telescope to the observer are transferred rapidly via a satellite link. If traditional astronomers are already finding observing with the VBT lacking the thrill and romance of earlier times they are bound to be even more disappointed with the planned mode of operation in the new observatory. It may never happen again that the first spectrum of a strange object is being taken while the astronomer sits guiding at the prime focus cage with the strains of Beethoven's Ninth Symphony filling the background. We are on the threshold of a new era.

The Giant Metrewave Radio Telescope (GMRT)

GMRT has become the most powerful facility in the world for astronomical research in the metre and decimetre wave bands.

By **Prof. Govind Swarup**
National Centre for Radio Astrophysics,
Tata Institute of Fundamental Research
Pune University Campus, Pune 411007.

Radio Astronomy is the study of the Universe through radiowaves reaching the earth. The constituents of the universe are the Sun, Planets, Stars, Galaxies etc. This science was born in 1931 when Karl Jansky discovered radio noise coming from the Milky Way. Like light waves, radio waves are also electromagnetic in nature but have much longer wavelengths. Different celestial objects radiate in different regions of the electro magnetic spectrum, such as X-rays, optical light, ultra-violet, infrared or radio waves, which depends on the physical conditions in them such as matter and electron densities, temperature of the medium, energetics of the objects, magnetic fields, etc.

A Giant Metrewave Radio Telescope (GMRT) has been set up recently by TIFR as a National Facility at Khodad, near Narayangaon, 70 kms. north of Pune and 120 kms east of Mumbai. The academic headquarters of the GMRT are located in the University of Pune. GMRT has become the most powerful facility in the world for astronomical research in the metre and decimetre wave bands (30 MHz to 1420 Mhz). It has been fully designed by Indian scientists and engineers and fabricated indigenously

It is a very versatile instrument. It allows investigation of a wide variety of celestial objects, reaching from our solar system to the very end of the observable Universe. An important scientific goal is to verify the prediction of Big Bang Model for the origin of the Universe, according to which galaxies must have condensed out of massive clouds of neutral hydrogen, which can be observed only at metre wavelengths, through their highly redshifted 21-cm line radiation.

Using a variety of radio telescopes, radio astronomers have discovered many objects such as radio galaxies, quasars and pulsars which are strong sources of radio waves. These radio waves generally arise from interaction of highly energitic electrons and magnetic fields that are created at the aftermath of violent and catastrophic events occuring in star explosions and in the ultra strong gravitational fields in the central regions of galaxies. The nuclei of some galaxies are believed to contain 'black holes' of millions of solar masses concentrated in a volume similar to that of our Solar system! Black holes are objects which are so highly condensed that nothing, not even light, can escape out of their strong gravitational pull. Their study is one of the most fascinating and challenging probems of modern astronomy. Radio and X-ray astronomers have provided a clear evidence of the existance of balck holes in our Galaxy and nearby galaxies.

Tools of Radio Astronomy

The basic tool of radio astronomy is a radio telescope. It consists of a reflector, a feed and a receiver system. The reflector focuses the radio waves from a distant celestial object on to the dipole feed which collects the radio signals. These weak signals are then amplified and processed by a sophisticated electronic receiver system.

The two most important features of a telescope are a high sensitivity to be able to detect radio waves from the most distant celestial objects in the universe, and a high resolution to be able to distinguish features of these objects in the sky. Larger the size or 'Effective collecting area' of a telescope, higher are its sensitivity and resolving power.

Because of the long wavelengths of radio waves the resolution of even a large single radio telescope is much poorer than that of a small optical telescope.

The limitation can be largely overcome by the technique of 'aperture synthesis interferometry' by combining the output of several radio telescope spread over a large area, exceeding many kms in extent. Radio astronomers can thus obtain extremely high resolutions. In fact these resolutions are much higher than that possible even with optical telescope located in space such as the Hubble Telescope. This is made possible by Very Long Baseline Interferometry (VLBI) in which radio signals from celestial object are independently recorded digitally on tapes along with atomic clock data by different telescopes separated by thousands of kilometres and subsequently correlated in a computer.

Why Metrewave ?

India offers unique advantage for radio astronomical observations at metre wavelengths. These are (I) a much lower degree of man-made radio-frequency interference than that which exists in developed countries; (II) the labour incentive nature of metrewave radio telescopes; (III) experience gained by TIFR in the design and construction of low cost antennas such as the Ooty Radio Telescope (530m long and 30m wide parabolic Cylinderical Radio Telescope built by TIFR during 1965 to 1970) (IV) coverage of both northern and southern skies from a location in southern India. Today there are challenging astrophysical problems which can be studied only at metrewaves and GMRT has been specifically designed to investigate these, while retaining a versatility that will allow it to be useful for a much wider range of studies.

Array Configuration and Scientific Objectives

GMRT consists of 30 parabolic dish antennas of 45-m diameter of a novel design. 12 of the 30 antennas are placed in a central array, about 1x1 sq.km. in size and six each lie along three, 14 km - long arms which together form a Y - shaped array. It operates as an "Earth - Rotation Synthesis Radio Telescope" giving a resolution of about 2 arc-secs at 1420 MHz. The above configuration has been selected following detailed computer studies to satisfy three major scientific objectives, namely high-resolution radio imaging of the Sun, as well as galactic and extra galactic radio sources such as quasars, radio galaxies, supernova remnants, H-II regions, The Galactic Centre, etc. to search for massive neutral hydrogen which are expected to have existed some 12 billion years ago prior to the formation of galaxies according to the Big bang model of the Universe, and to search for millisecond and binary pulsars which presently provide unique laboratories for testing the General Theory of Relativity.

The total effective area is about 30,000 sq.mt. at about 600 MHz and about 27000 sq.mt. at 1420 MHz. This is nearly the same as that of the Arecibo Radio Telescope in Puerto Rico in USA, but GMRT has a wider declination range and less susceptibility to radio interference. Its collecting area is about four times that of the Very Large Array (VLA) in New Mexico, USA, which consists of 27 antennas of 25 - m diameter placed in a Y - array with 21-km arms.

Science With GMRT

Over the last two years, many new results have been obtained with GMRT concerning objects in our Galaxy, such as intergalactic matter, ionized hydrogen region (H-II regions) which are birthplace of stars, supernova remnant which arise at the end of the cycle of a massive star when its nuclear fuel gets exhausted, the exotic pulsating radio sources (pulsars) which are associated with Neutron Stars (which get formed when a massive star collapses), Centre of our Galaxy, etc.

GMRT has also given new results concerning radio galaxies, quasars, neutral hydrogen in culster of galaxies andthe mysterious Damped Lyman alpha clouds.

Carrier Opportunities

GMRT has been set up by TIFR as a major national facility. GMRT offers an extraordinary opportunity to Indian scientists and students (M.Sc. in Physics or B.E., B.C.S/B.Tech. in Electronics or equivalent) to work at the frontier of astronomy, image processing and related areas of physics.

GMRT also offers exciting opportunities for engineers and computer scientists (B.E. or equivalent degree) to work at the state of art technologies.

Meteor Observations

Entertaining & Scientific

The celestial spectacle

Rainer Arlt,
International Meteor Organization

Showers of Meteors

In each cloudless night, every now and then, you can see a shooting star darting through the sky. In some periods of the year, these meteors appear more frequently from one point. The media have reported a lot about the Leonid meteor storms in November when the vigilant observer could spot several hundred or even a thousands of meteors during the peak hour.

The name of these meteors originates in the constellation of Leo from where most of the shooting stars seem to emanate. The meteors do appear in all parts of the sky, but their backward prolongation lead to a common intersection point in constellation Leo. Meteors which have such a common radiant belong to a meteor shower. Another example is the Perseid shower having its maximum near August 12/13 every year.

Many other meteor showers, most of them delivering much fewer meteors, are known, but the strongest of them best attract new observers to the field of meteor astronomy. These are the Perseids near August 12/13, the Geminids near December 13/14, and the Quadrantids near January 3/4 and of course Leonids November 17/18. What about this meteor science, is it more than fun giving rise to an observation of shooting stars?

Meteors are caused by millimeter-sized particles that enter the Earth's atmosphere and disintegrate. The collisions with molecules of the atmosphere excite various atomic emissions of light. The enormous entrance velocity implies a very high energy being released in the moment of entry, thus making the streak of light visible down to the ground where we observe. The particles causing a meteor shower move on nearly parallel orbits around the Sun. Such a meteoroid stream, as they are called, is typically caused by a comet. When the comet is near the Sun, a lot of gas and dust is ejected. The very smallest dust grains form the dust tail; the larger ones - millimeter-sized and larger - are too heavy and move on nearly the same orbit as the comet. They slowly drift away and may finally end up on an orbit where they are able to hit the Earth.

The meteors we observe are therefore tracers of cometary activity. Each time the comet is near the Sun, near the orbit's perihelion, new dust is ejected. When we observe the corresponding meteor shower, we see material from various epochs of the comet's life. Learning about the motion of the particles in space and the physics at their origin on the comet is one part of meteor science. Learning about the atmospheric physics connected with the flight of a meteor, is another part of meteor science.

Why observing meteors?

Amateur astronomers around the world are observing meteor showers and collect huge amounts of data. The full dataset allows the determination of the actual number density of particles in meteoroid streams. Time and strength of the peaks of meteor activity are compared with computer models connecting the ejection of dust with its possible arrival on Earth. The prediction of Leonid meteor storms has been possible with an accuracy of roughly 10 minutes, although the particles were ejected more than a hundred years ago!

It is a challenge to successfully connect observations and models also for other meteor showers, for example, for the Perseids. Their meteors were excellently observed by many amateurs in 2002 with a night of maximum activity on August 12/13. The parent comet is 109P/Swift-Tuttle with an orbital period of roughly 130 years. The return of the comet to its perihelion in 1992 was accompanied by a series of 12 years of heightened activity of the Perseids. As we have seen already, the particles need to drift away from the comet's orbit towards orbits that actually intersect with that of the Earth. Hence, the particles seen in 1988-1999 were not ejected from the comet during the last approach to the Sun in 1992, but several revolutions ago.

Models now predict, that another cloud of material gets close to Earth in 2004, despite the return of Perseids' activity to normal annual rates in 2000-2002. It will be a break-through of models if the computations work not only for the Leonids, but also for the Perseids. The proof, however, requires a large number of observing reports for two reasons: (i) The statistical scatter in human observations is naturally large, and the average meteor rates must be based on a firm number of observations in order to be meaningful. (ii) The shower should be monitored from all geographical longitudes in order to obtain a gap-less profile of hourly meteor rates.

Observers from about 40 countries including India are reporting data to the International Meteor Organization. Indian amateurs typically report 100-200 observing hours per year, logged in Maharashtra and the Pune area in particular and at various other places thanks to the efforts made at IUCAA.

Despite high Perseid activity along with the comet's return to the Sun's vicinity, we can observe fairly good rates of the shower every year. If the observer is in the right geographical position to see the highest part of the activity curve, he may witness more than 50 meteors per hour. These visible numbers are converted into a standard measure of activity: The Zenithal Hourly Rate (ZHR) which accounts for the fact that more meteors are visible when the radiant in Perseus is high in the sky. The ZHR is corrected for a radiant position overhead. Such a position cannot be reached as seen from India, that is, the visible numbers lay behind the maximum ZHR of about 100 and reach 50 or 60 under good viewing conditions.

The Figure shows the activity profile of the 2002 Perseids. The shower exhibited a very typical appearance. The broad maximum is caused by particles having left the comet at least 10 revolutions ago. Material ejected more recently may cause additional spikes such as in 1988-1999 with a narrow activity peak several hours before the traditional maximum. Such a spike is predicted for 2004.

How to observe meteors

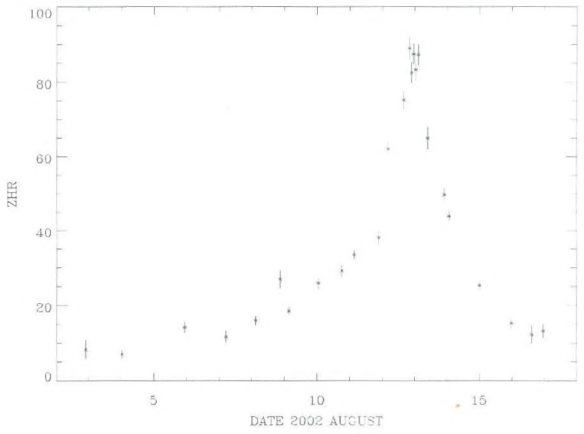
Every amateur astronomer can contribute to the global picture of meteor shower. The ZHR is a measure for the activity as seen by a single observer. It is therefore very important that each observer takes his individual notes about meteors and their stellar magnitudes. It does not matter if the same meteor was seen by two people. What we need is the statistical result of how many meteors a single observer can see. Meteors should be classified in two groups, those coming from the radiant are shower members, the others are non-shower members. In a Perseid observation, the shower meteors come from the northern end of Perseus, the others have to be noted as non-Perseids. In a Leonid observation, the actual Leonids come from the western part of Leo, while the others are non-Leonids. All meteors are noted with an estimate of their stellar magnitude; whole magnitude classes are sufficient.

Another important measurement is the estimation of the sky and observer's eye quality. We use the stellar limiting magnitude (LM) for comparing observations from different locations or different people. It is the magnitude of the faintest star readily visible to the naked eye, typically between +5 and +6.5. This LM does not only measure the sky quality, but also the perception of the individual observer. It must be determined by each observer individually.

The report is completed by information about the observer's name (surname in capitals), the location and geographical position. If you wish to improve your reporting according to the standard report form of the International Meteor Organization, please refer to the internet page

http://www.imo.net/visual/index.html

for further reading. But even simple meteor logs from a first attempt of meteor watching can be helpful. We look forward to receiving your contribution!



Distances To The Stars

Introduction to measuring distances in Astronomy

Ajit K. Kembhavi
Inter-University Centre for
Astronomy and Astrophysics, Pune

The stars that we see in the night sky, with the naked eye and with telescopes, belong to a very large structure called the Milky Way Galaxy. This has more than a hundred billion (ten thousand crore) stars in it, which are distributed in a thin disk, with a bulge in the centre, and with spiral arms. The radius of the disk is so large that light, moving at a speed of 300,000 kilometres per second, would take about 50,000 years to travel from the centre of the Galaxy to the periphery of the disk. The stars are therefore distributed at great distances from us, and it has required many ingenious techniques to measure these distances. We will describe some of the simpler and more important techniques in this article.

Why is it so important to measure the distances to the stars? From measurements made on the Earth, it is possible to determine what is the apparent brightness of a star. But the nature of a star depends on its absolute brightness or luminosity, which in turn depends on the distance to the star. So we need to find the means to determine the distances to a number of stars. Knowing the distances will also tell us how stars are distributed in the Galaxy, which is very important to understand the nature of the Galaxy, and how it was formed. And if we are able to measure the distances to other Galaxies besides our own, we will get an idea about the distribution of matter in the whole Universe.

Measuring distances to the stars is extremely difficult because they are very far away. The nearest star to us, the Sun, is about a 150 million kilometres away. The next nearest star, Proxima Centauri, is about 300,000 times further than the Sun, and that is only the beginning of large distances which are encountered in astronomy. It is not practical to use units such as centimetres or kilometres to measure these distances, because then one has to deal with very large numbers, which is inconvenient. Within the Solar system, it is usual to use a practical unit known as the Astronomical unit which is equal to the average distance between the Sun and the Earth, and is about 150 million kilometres. But even a measuring rod of such great length is not good enough a unit for expressing the vast distances to the stars.

Distances from the Sun

Object	Distance	Comment
Moon	380000 kilometres	Distance from the Earth
Earth	150 million kilometres	
Mars	227 million kilometres	
Pluto	5900 million kilometres	
Proxima Centauri	4.2 light years	Star nearest to the Sun
Sirius	8.6 light years	
Betelgeuse	480 light years	
Andromeda Galaxy	2.2 million light years	Nearest major galaxy

Units of Distance Useful to Astronomy

A natural unit to be used to measure distances to the stars is the light year, which is the distance traveled by light in one year. The speed of light, while moving through vacuum is 300,000 kilometres per second. Interstellar space, which is the space between the stars, contains very little matter and may be considered to be a very good vacuum. As a ray of light travels from a distant star towards the Earth, it covers 9 million, million kilometres in a year. Astronomers use this distance, called a light year to measure distances beyond the Solar system. They also use another unit, called the parsec, which is approximately 3.3 times a light year. For very large distances the units often used are the kiloparsec, which is 1000 parsec, or the Megaparsee, which is one million parsec. Some important distances and sizes are shown in Table 1.

Triangles to the Stars

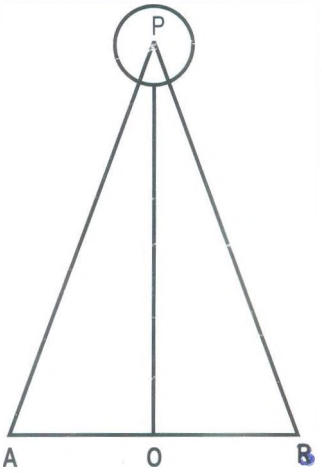
The astronomer has a repertoire of many different methods for measuring distances. These depend on the nature of the object, how far away it is located, and the accuracy desired in the distance measurement. Simple methods can be applied when only a rough measurement of the distance is required, while more difficult and time consuming techniques are needed when the distance is to be determined as accurately as possible.

Distances to the Moon and the Sun

To see how the distances to a star can be measured, let us consider the simple problem of measuring the height of a very tall pole, without having to actually climb it. Let us draw a line A, which passes through the base of the pole at point 0. Let us suppose that 0 is at the midpoint of the line AB, though this is not strictly necessary. The line AB is called the baseline. Now consider the triangle PAB. It is very easy to actually determine what the angles of the triangle at the base are. A simple way to do this would be to mount a long tube close to the ground at point A, and turn it until the top of the pole is visible through the end close to the ground. The inclination of the tube with the line AB then gives the angle at A. The angle at B can be similarly determined. When two angles of the triangle are known the third angle, at P, is known too, since the sum of the angles is 180 degrees.

When we know the length of one side of the triangle, which is AB, and all the angles, then we can determine the length of all the sides, using simple mathematics. This is known as "solving the triangle". It is then very easy, using Pythagoras' theorem to determine the height of the pole PO, which is the task we set out to do. This method, known as triangulation, is routinely used to measure the distances and heights of places on Earth which are difficult to access, like the top of Mount Everest in the Himalayas.

To measure the distance to a star, we can imagine it to be sitting at the top of a very tall pole, construct a triangle to it, and use the method we have described above. But stars are very far away, and the angle at P in Figure will be too small to be measurable, unless we have a large enough baseline AB. The biggest baseline we now have access to is the diameter of the Earth's orbit around the Sun, which is about 300 million kilometres.

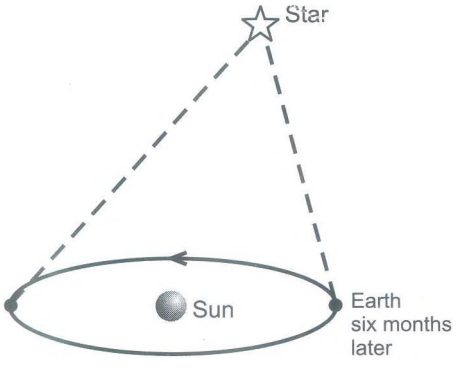


Measuring the height of a pole by triangulation. AB is the baseline. Knowing the length of AB and the angle at P, the height of the pole can be calculated.

To use triangulation on a particular star , we need to image the star against its background on some date, and then once again six months later, when the Earth is on the diametrically opposite side. The star is then viewed from a different direction, and will appear to have moved against the background of more distant stars. From the apparent motion of the star the required angles can be determined. Since the diameter of the orbit is known, triangulation again provides the distance to the star.

The more distant a star is from us, the less it will appear to have moved against its background. The apparent motion therefore can only be detected for the closest stars. Distance through triangulation was first obtained for the star 61 Cygni in 1838 by the German astronomer and mathematician F. W. Bessel, who found that the star was at a distance of 11.2 light years. Distances to several hundred stars, which are less than about 60 light years from us, have been accurately determined. This requires positions of the stars to be determined with an accuracy of about 2 millionths of a degree, which is difficult to do, because of the blurring effect produced on the images of stars by the Earth's atmosphere.

The accuracy of distance measurements for stars which are further than about a hundred light years decreases rapidly with increasing distance. To get over this limitation, and to measure greater distances, it is necessary to make measurements using telescopes based on satellites in orbit around the Earth, outside the reach of the atmosphere.



Measuring the distance to a star by triangulation. The direction to the star is measured from the Earth at some point in time, and then again six months later. This provides a triangle with the diameter of the Earth's orbit as the base.

A special satellite called Hipparcos, dedicated to measure the positions and brightness of stars was launched in 1989, and data on about 2.5 million stars has been obtained by measurements performed from it. Accurate distances are available for over a 120,000 stars, but the furthest accurately measured distances are typically less than several hundred light years. So in spite of the tremendous increase in known distances over measurements made from the ground, we have still probed just a small volume of the Galaxy close to us. We need other techniques for distance measurements, so that we can explore further into t he Galaxy, to obtain an idea of the overall distribution of stars, and to discover rare objects which are not present in our neighborhood.

Distances to Variable Stars

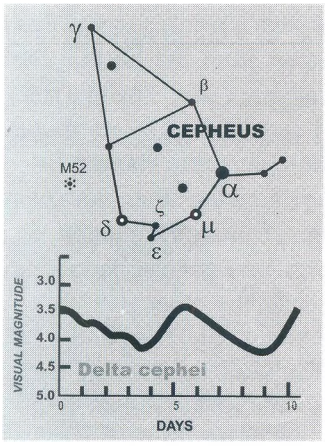
The apparent brightness of a number of stars in the sky changes with time. These are called variable stars. The stars change their brightness in a cyclic manner, alternately getting brighter and fainter. There are different patterns of variation known, and these provide a clue to the reason for the changing brightness. The time taken by a star to pass through one complete cycle of variation, from a maximum in brightness to a minimum, and then back to the maximum, is known as the period of variation.

The brightness of a star can vary for different reasons. One possibility is that an object which appears to be a star, really consists of two stars going round one another. The distance between stars of such a pair is so small that they cannot be seen apart from the Earth. Such an object is called a binary star. The two stars in a binary are bound together by their mutual gravitational attraction, and each star can be considered to be moving round the other, like a planet going round the Sun. During this motion, as observed from the Earth, one star can periodically cover, wholly or partially, the other star. When this happens, the apparent brightness of the pair is diminished from the level seen when both stars are fully visible. This is like a Solar eclipse, in which the Moon passes between the Sun and the Earth, cutting off light reaching us from the Sun. Since the motion of the stars repeats periodically, the changing brightness is periodic too. A binary which shows such periodic change of brightness is

called an eclipsing binary. From the pattern of the change, much can be learnt about the relative sizes of the stars, their distance from us, the orientation of the plane of the orbit and so on.

We are concerned here with another kind of variable star, which varies in brightness due to changes which occur within the star itself, causing it to pulsate. As the star becomes bigger or smaller, the amount of light emitted by it changes, causing its apparent brightness as measured from the Earth to change with time. There are different kinds of pulsating stars, and of these, stars which show a specific pattern of variation are called Cepheid variables. This group of stars is so named because the first star in which the particular pattern was discovered is located in the constellation Cepheus.

A very important property of Cepheid variables was discovered by the American astronomer Henrietta Levitt. She found that the period of variation of Cepheids was related in a simple manner to their absolute brightness or luminosity, which is the total amount of energy emitted by the star per second. So if we find that a particular star shows the pattern of variation expected of a Cepheid, then from the period of the star we can find its absolute brightness. This is related to its apparent brightness, which can be measured accurately. The distance to the star can then be found from the inverse square law which states that the observed brightness of a given star is proportional to the inverse square of its distance from us.

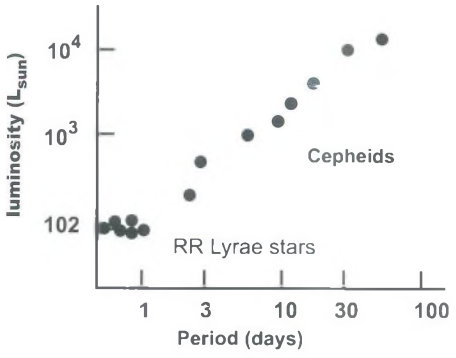


The Cepheid variable delta Cephei in the constellation Cepheus is shown in the upper part of the figure. The variation in the intensity of light received from the star over a period several days is shown in the lower part of the figure.

There are many complications in measuring distances with the help of Cepheids, or other kinds of variables, like the RR Lyrae stars. For example, there are actually two slightly different kinds of Cepheids, and these have to be separately considered. Otherwise, serious errors can occur in the distance estimation.

Another difficulty is that interstellar space has small quantities of matter, which absorbs or scatters some of the light from the stars. This makes the stars appear to be fainter than they should be, given their luminosity and distance. If this is not taken into account, the distances are overestimated.

Inter-stellar matter also changes the colours of stars, because it tends to scatter blue light more than red light. This is similar to the action of the Earth's atmosphere on sunlight: When the Sun is high up in the sky, it appears to be pale yellow in colour, but when it is rising or setting it appears to be red. This is because when the Sun is close to the horizon, rays from it have a longer path through the atmosphere, than when it is at the zenith. The atmosphere scatters more of the blue light than the red. Since the bluer part of the Sun's spectrum is removed, it appears to be redder than it actually is. The change in the colours of stars can be used to estimate the amount of interstellar matter along the line of sight. Observations at radio wavelengths can also be used for this purpose. This information has to be used in estimating correct distances.



The relation between the luminosity, that is the light energy emitted per second, and the period of variation of light is shown for several Cepheid variables. If a new Cepheid is discovered, its luminosity can be estimated from the variability period, which is easy to measure. Several RR Lyrae stars, which shown in the figure. are another kind of variable stars used as distance indicators, are also shown in the figure.

Island Universe?

Cepheid variables have played a crucial role in distance determination in astronomy. A particularly spectacular case is the determination of the distance to the Andrornedа nebula, which was seen as a fuzzy patch, even with small binoculars, in the constellation of Andromeda, by the great American astronomer Edwin Hubble. In the early decade of this century, it was thought possible that this nebula, and many others like it, were located within the confines of our own Milky Way galaxy. In this view, originated by the philosopher Immanuel Kant and known as the island universe model, everything in the Universe was located in our Galaxy, making it like a lonely island in the vast expanse of space. Other people suggested that the nebulae were galaxies in their own right, as large as ours, and made up of very many stars.

The difficulty in choosing between these two models was that the distances to the nebulae could not be determined, and in fact they could not even be resolved into individual stars. It was the great astronomer Edwin Hubble who first managed to observe individual stars in the Andromeda nebula. He found, through very difficult observations, that one of the stars was a Cepheid variable. The observed period provided the absolute brightness, from which the distance could be determined. This distance, the modern value for which is about 2.2 million light years, was found to be vastly greater than the known size of our Galaxy, which is about a hundred thousand light years. It was thus established that Andromeda is a spiral galaxy quite similar to our own. That was the end of the island universe model. Hubble later went on to establish, from his studies of distances to galaxies, that the Universe is expanding, in the sense that the galaxies are all moving away from one another.

The distance ladder

Astronomers use many different techniques to determine distances to the stars. Distances determined using triangulation, or related techniques, are the most reliable. This is because the principles used are very simple, and very few assumptions have to be made about the nature of the objects. But as we pass to the use of variablestars, and other less certain techniques, the distance determinations become more shaky.

One can imagine that there is a very long ladder, which takes us from the nearest star to the most distant galaxies, with each rung of the ladder involving a new technique. When we get to the realm of the really large distances between galaxies, the expansion of the Universe has to be used in establishing distances, and here the uncertainty is high. From time to time new discoveries are made, which change our ideas about the size of the Universe, but a consensus about the true size is yet to emerge. This keeps the work of the astronomer from becoming a matter of routine measurements and surveys. There are enough uncertainties and pitfalls for the astronomer's life to remain exciting and the work challenging.

Mutual Events of Jovian Satellites

Over next 8 months Jupiter's moons will be eclipsing each other.

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The prediction by Peale et al. (Science, **203,** 892, 1979) on the eve of Voyager I's encounter with Io of widespread and recurrent surface volcanism and its dramatic confirmation during the flyby has evoked considerable interest on the orbital evolution of this satellite. In addition, infrared heat flux from this innermost satellite is in excess of what one expects for an object at the distance of Jupiter from the Sun (McEwen et al. 1985, J. Geophys. res. **90,** 12345). The source of this heat has been attributed to tidal heating. The energy for tidal heating must come from Io's orbit and this will cause the orbit of Io to shrink. There exists an orbital resonance (Laplace resonance) between Io, Europa and Ganymede. On a long time scale, the orbit shrinkage will have the effect of driving the system out of resonance. On the other hand, tides will also be raised on Jupiter by Io and this will have the opposite effect as its effect would be to expand the orbit of Io. Thus, one of the several key issues in the study of solar system objects concerns the evolution of Jupiter's Galilean satellite system. Accurate measurement of the changes in the mean motion of these satellites holds the key to the solution. To obtain such informations one needs to know accurate positions of the satellites over the duration of several decades. The data sets that are used for such studies include photographic astrometric data, timings of the four Galilean satellites eclipse behind the shadow of the planet, and the mutual events between any two satellites. The mutual events are capable of yielding relative astrometric positions at least an order of magnitude more accurate than the photographic observations.

The mutual events occur twice during the orbital period of Jupiter when the orbital plane of the planet crosses the inner solar system. For about a year, pairs of satellites of Jupiter can be seen eclipsing when these are aligned with the Sun, and occulting when aligned with the Earth. Predictions of these events for selected locations and several technical notes on the observations are available at the website of L 'Institut de méchanique céleste et de calcul des éphémérides, Paris.* Unlike the predictions of asteroid occultations, the predicted timings of the mutual events for different stations are within 1-2 seconds, hence predictions for any station within India would be sufficient for all the stations.

* http://www.bdl.fr/phemu

Although very accurate, the full potential of the mutual event data can only be realized if the observations are carried out with extreme care. The timing accuracies are very important. Hence a GPS clock or synchronization to Radio time signals is important. An accuracy which is better than 0.1 sec is considered ideal while any thing worse that 1 second has very little use. Due to proximity of bright Jupiter, especially for the events occurring close to the planet, scattered light from the planet has to be evaluated carefully. Observers using conventional photoelectric photometry must evaluate the sky background on all four sides of the satellites. The size of the diaphragm should be small; a diameter of 24 arc-sec would be ideal. Observers using CCD based web-camera may avoid the planet by throwing it out of the field if possible. The auto-contrast feature in the software must be disabled, otherwise, the system will continuously adjust the contrast of every frame and the observed depth of the light curve will be of little use. Due to finite size of the satellites, the events are gradual, hence unlike the asteroid occultation events, visual observations of mutual are very difficult.

During the event, the occulting and occulted satellite images merge. This also happens for the eclipse events occurring close to the opposition of Jupiter. Hence in order to evaluate the magnitude drop accurately, it is important to take images (or counts) of the individual satellites either before or after the event. On some occasions, a third satellite may be very close to the field. Observers carrying out photoelectric photometry must record this in the observing log to avoid confusion when the data is fitted to the model. It is advisable to use broad band filters and the filter information should again be documented in the header information. This is important as the contrast between the occulting (eclipsing) and the occulted (eclipsed) satellites depends on the wavelength band of observations.

The observations can be directly reported to L 'Institut de méchanique céleste et de calcul des éphémérides. The group at this Institute has been systematically documenting all the observed events since 1973.

Sky Watch

On these pages we bring you the general information about when and what to look for in the sky. This feature is divided into three sections: a) Planets Watch, b) Sky Events and c) Starry Sky.

Planet Watch

In this section we deal with the naked eye planets only. The tables here tells us when a planet will rise, set or transit. This will give you a general idea as to where to look for these planets. If a planet is rising you should look for it in the east and if it is setting, look for it in the west. Since it is not practical to give exact time for different cities we have given these with respect to the sunrise and sunset time. So please plan your observing schedule after checking the sunset and sunrise time for you city. You should find these timings in your local newspaper.

A planet is said to transit when it crosses the observer's meridian, which is an imaginary line on the sky joining north and south poles and the point right overhead called zenith. For Mars, Jupiter and Saturn these times are given only for their night time transit and for Venus it is given for it's day time transit.

Venus can be seen in broad daylight if you know where to look for it. You can use transit time of Venus to locate it in the sky even when the sun is well above the horizon. With this time we have also given declination of Venus.

Planets in October, November and December

In October **Mercury** can be seen in the morning though with some difficulty. It is with Mars on 10th of Oct. It will be too close to the sun to be seen in November and then it reappears above the western horizon soon after the sunset in December.

After its spectacular display in the evening sky until September, **Venus** takes a break in October and reappears in the morning sky in November. It quickly climbs above the eastern horizon and can be seen sparkling in the crisp morning sky of the winter. As it moves from evening sky to morning sky it would pass its nearest distance from the earth.

Follow Venus using a telescope. It will be about 60 seconds of arc and its crescent phase can be seen as it over takes the earth its angular size would decrease but at the same time phase would increase too. It pairs up with Mars on December 6th.

Mars is in the morning sky and moves from Leo to Virgo in October but it is still too close to the sun. From November onwards it can be seen well above the eastern horizon before the sunrise. Moon will be occulting Mars on 30th of December the event however will not be seen from India.

Look for Mars and Venus before the dawn from about mid November till December end. Mars is approaching the horizon where as Venus is climbing up. Mars pairs up with Spica (Alpha Virginis = Chitra) on 21st of November. On December 1st Moon joins them but in the meanwhile Mars has moved to Venus. They pair up on 7th of December and remain with each other till the end of the month. It is a good 'celestial dance' between Mars, the God of Wars, Venus, the goddess of beauty and Spica, the 'Ear of Corn' in hands of Virgo the Virgin, to record photographically.

Jupiter starts rising soon after midnight and is well above the eastern horizon at sunset. It moves from Gemini to Leo in November and would be very close to the radiant of Leonid meteor shower on Nov 19.

In October **Saturn** is in Orion and it moves into the boundary of Taurus towards end of November. Close to mid December it rises as the sun sets and would be visible all through the night.

Locating Venus in the day light

Locating Venus during the daytime is a great fun and this is what you should do to locate it. First find out at what time, in IST does Venus transits for your place of observation. Subtract latitude of your place form the declination of Venus if this number comes out to be negative then you look for Venus at the transit time by those many degrees south of zenith. If the number is positive then you look north of zenith. For example on Dec. 20, 2002 Venus would transit over Pune, Latitude 18deg 30m, at 9:29 IST and the declination of Venus is -12deg. 58 min. Now subtracting latitude of Pune from declination of Venus gives me -31 deg. 29 min. So if you look about 31.5 degrees south of zenith you should find Venus there on 20/12/2002 at about 9:30. You may start with using a pair of binoculars and once you have located Venus try to locate it with naked eyes.

Planet schedule

October 1

Mercury	Too close to the sun, rises just about 30m before the sun	
Venus	Sets about 1h 40m after the sun	Tr. about 8h after sunrise, Dec -22 02'
Mars	Rises about 1h before the sun	
Jupiter	Rises about 4h before the sun	
Saturn	Rises about 5h after the sunset	Tr. about 30m before sunrise

October 10

Mercury	Rises just about 1h before the sun	
Venus	Sets about 1h after the sun	Tr. about 7h 30m after sunrise, Dec -23 16'
Mars	Rises about 1h 24m before the sun	
Jupiter	Rises about 4h 30m before the sun	
Saturn	Rises about 4h 24m after sunset	Tr. about one hour before sunrise

October 20

Mercury	Rises just about 1hr before the sun	
Venus	Sets about 45m after the sun	Tr. about 6h 45m after the sunrise, Dec -22 35'
Mars	Rises about 1hr 40m before the sun	
Jupiter	Rises about 5h before the sun	
Saturn	Rises about 3h 50m after sunset	Tr. about 2h before sunrise

November 1

Mercury	Rises just about 35m before the sun	
Venus	Rises almost along with the sun.	Tr. about 6h after the sunrise, Dec -19 19'
Mars	Rises about 2h before the sun	
Jupiter	Rises 5h 45m before the sun	Tr. at about sun rise
Saturn	Rises about 3h after sunset	Tr. about 3h 25m before sunrise

November 10

Mercury	Sets 10m before the sun	
Venus	Rises about 1h before the sun	Tr. about 4h 36m after sunrise, Dec -15 16'
Mars	Rises about 2h before the sun	
Jupiter	Rises by about local midnight	Tr. at about sunrises
Saturn	Rises about 2h 30m after sunset	Tr. about 3h 25m before sunrise

November 20

Mercury	Sets 10m after the sun	
Venus	Rises 2h before the sun	Tr. about 3h 46m after sunrise, Dec -12 13'
Mars	Rises about 2h 30m before the sun	
Jupiter	Rises soon after local midnight	Tr. 40m before sun rise
Saturn	Rises about 1h 50m after the sunset	Tr. 4h before sunrise

December 1

Mercury	Sets about 35m after the sun	
Venus	Rises about 2h 40m before the sun	Tr. 3h after sunrise, Dec -11 02'
Mars	Rises about 2h 50m before the sun	
Jupiter	Rises about 4h 50m after sunset	Tr. 1h 30m before sunrise
Saturn	Rises about 1h after sunset	Tr. 5h before sunrise

December 10

Mercury	Rises just about 1h before the sun	
Venus	Sets about 3h before the sun	Tr. about 2h 40m after sunrise, Dec -11 28'
Mars	Rises about 3h 24m before the sun	
Jupiter	Rises about 4h before the sun	Tr. about 2h before sunrise
Saturn	Rises about 4h 24m after sunset	Tr. about 5h 50m before sunrise

December 20

Mercury	Rises just about 1h before the sun	
Venus	Sets about 45m after the sun	Tr. about 6h 45m after sunrise, Dec -12 58'
Mars	Rises about 1h 40m before the sun	
Jupiter	Rises about 5h before the sun	Tr. about 2h before sunrise
Saturn	Rises about 3h 50m after sunset	Tr. about 2h before sunrise

Phases of Moon

Lunar phases are another pointer for planing sky watch sessions. Full moon or near full moon period is bad for watching faint and nebulas objects. When it's the first quarter, the moon will be seen close to meridian at the time of sunset. This date also tells us that the moon will be setting close to (local) midnight. Similarly the moon will be seen close to the meridian at sunrise when it is at it's last quarter phase. A two or three days before and after its new moon phase thin crescent moon can be seen above the eastern and western horizon respectively.

New Moon		First Quarter		Full Moon		Last Quarter	
6 Oct	16:47	13 Oct	11:03	21 Oct	12:50	29 Oct	10:58
5 Nov	02:04	12 Nov	02:20	20 Nov	17:04	27 Nov	21:16
4 Dec	13:04	11 Dec	22:19	20 Nov	00:40	27 Dec	06:01

Sky Events

Tabulated here are some interesting events for you to watch in the sky. These events are also categorized as evening (E) or morning (M) events and if there is a time associated with an event it is given.

These days a beautiful variable star is seen in the sky. It is Algol in the Perseus constellation (check the star maps). Algol is a binary star, a system of two stars revolving around each other. Their orbital plane happens to be almost in the line of sight with the Earth. Thus when the cooler component of this binary system is directly between us and the brighter one, eclipsing it, we see drop in light from Algol. It varies in brightness over a period of about 2 days 20 hours and 49 minutes. This period, however, is slowly lengthening. Algol's magnitude changes from 2.1 at maximum to 3.4 at primary minimum. This change is so large that it is clearly visible to the naked eyes. It takes about 5 hours for the star to become faint and another five hours for it to regain its original brightness. Watch this star fading away or brightening up. The timings given here are for its minimum phase.

October * Times in IST

2	M	Moon about 6 deg. north of Jupiter
5	M	Thin crescent moon 5 deg. north of Mars
8	E	Venus south west (left below) of thin crescent of moon, 2.7 magnitude stars Zubenelgenubi within 2 deg. of moon
10	04:04	Minima of Algol (note its on the night of 9th)
10	E	Still a crescent moon, about 5 deg above Antares (Jyestha)
12		Moon passes within a few minutes of arch, north of 2nd mag. star Nunki, a good event to watch and photograph
13	01:53	Minima of Algol (note its on the night of 12th)
15	22:41	Minima of Algol
18	19:30	Minima of Algol
22		Orionid meteor shower peaks tonight
23	M	Mars pairs up with 3.8 mag star Zaniah (η Virginis) another faint stars between the two watch this event with binoculars
24		Near full moon below Pleiades (Kruttika) and Hyades + Aldebaran (Rohini)
30	M	Half moon north of Jupiter
31	M	Moon 5 deg north east of Regulus (Magha)

November

2	03:34	Minima of Algol
3	M	Mars about 5 deg. south of thin lunar crescent.
5	00:23	Minima of Algol
7	21:12	Minima of Algol
10	18:00	Minima of Algol
10		Still a crescent moon, about 5 deg above Antares (Jyestha)
12		Moon passes within a few minutes of arch, north of 2nd mag. star Nunki, a good event to watch and photograph
13		N Taurid shower peeks (about 12:30 IST)
15		Check for changing positions of Mars and Venus. See above.
18 -19		Leonid shower peaks on 19th (9:30 IST) start watching for it on the night of 18th.
20		Full moon between Pleiades (Kruttika) and Hyades + Aldebaran (Rohini).
22	05:16	Minima of Algol. Saturn 3 deg. south of Moon
24	02:05	Minima of Algol
26		Jupiter 4 deg. south of Moon
27	22:54	Minima of Algol
30	19:42	Minima of Algol

December

1	M	Mars and Venus right below Moon
4		Total solar eclipse not visible from India
7	M	Venus it at its brightest (see above for Venus and Mars)
14		Geminid meteor shower peaks
15	03:38	Minima of Algol
17		Near full moon south of Pleiades (Kruttika)
18	00:38	Minima of Algol
19		Full moon just about 2 deg. north of Saturn.
20	21:27	Minima of Algol
22	06:44	Winter Solstice, 2nd issue of Akashmitra
23	18:16	Minima of Algol
30		Moon occults Mars, not seen in India but watch the early morning sky Moon, Mars and Venus makes a beautiful triangle.

The Starry Sky

We have given here star maps for November and December. These maps are drawn for 15 of the month at 21:00 hrs Indian standard Time (IST), for the Central Station of India (CSI). The maps show slightly more sky than that will be visible from this station so that these can be used elsewhere in India at about 9 p.m. The maps can be used at about 10 p.m. early in the month or at 8 p.m. towards the end of the month.

Use a flashlight covered with red gelatin paper to read the map in the night. This will help you to see the stars without your eyes getting 'blinded' due to bright light from the torch. Stars on the map are indicated with dots of varying sizes. Bigger dot represents brighter star. Approximate magnitude of a star can be estimated using the scale given.

In the description that follows we have used names of heavenly bodes adopted by the International Astronomical Union. Indian names of some of these are given in square brackets [ ].

We start our observations from the western direction. Face west and hold the map so that 'West' marked on it is in the direction of your feet and 'East' is up (it will be read upside down). Now look right above the western horizon, you will see three fairly bright stars in almost a right angled triangle configuration. These stars belong to three different constellations. Star at the apex of the triangle is Deneb in Cygnus, the Swan [Hans]. The star to the right of the base of the triangle is Altair [Shravan] in Aquila, the Eagle [Garuda] and the one to the left is Vega [Abhijit], in Lyra, the Lyre [Swaramandal]. This group of stars was named summer triangle by Patrick Moor (we will talk about it at some other time). All the stars are the brightest stars in their respective constellations. Vega is also the brightest star in the northern hemisphere. The second brightest of the summer triangle Altair, Shravan is the 22nd Nakshatra.

About 9 degrees north east of Deneb is a cluster of stars that can be easily picked up using a pair of binoculars. It is designated as M39 which means it is 39th object in Messier catalogue. The stars of this cluster are loosely grouped together. Such a cluster is called open cluster or galactic cluster.

For the observers in the southern parts of India, Acherner [agra-nad] in Eridanus, the River [Yamuna] is just rising above the south-western horizon. For the observers in the northern parts this will be a too low. The name Acherner comes from 'Al Ahir al Nahr' or 'Akhir an-Nahr' meaning the End of the River. We call it Agra-nad or debaucher of river, Yamuna. The two opposite meanings for the same stars can be easily understood when you realize that from northern latitudes Acherner is seen very close to the horizon, almost at the end of the sky. But this is the first bright star of Yamuna to rise above the south-western horizon.

Right over head is one of the 'land marks' of the night sky is Great Square of Pegasus, the Winged Horse [Maha-ashwa]. You just cannot miss it. The sides of the square are almost aligned north-south and east-west. The stars on the western arm of the square make our 25th nakshatra Purva Bhadrapada and those on the eastern arm make 26th nakshatra Uttra Bhadrapada. Purva and Uttara are in the sense of earlier and later respectively, in their appearance in the sky and not in the sense of the directions.

Halfway between Pegasus and horizon is Cassiopeia [Sharmishata]. This constellation is in 'M' shape with right leg of 'M' pulled a too much to right. You might recall that Saptarishis are used for finding north direction in the night. This constellation can be used for finding north when Saptarishis are below the horizon. Take the first three stars of 'M' which make an equilateral triangle. Now take a perpendicular bisector of the line joining first and third star. This line, when extended towards horizon will go through Polaris [Dhruva], the Pole Star. Using a pair of binoculars if you scan on the line joining third and fourth stars of Cassiopeia and extending to east you will reach a binary open cluster of stars h & x. This is a lovely pair of open clusters.

Probably the most familiar object to the science-fiction readers (whether they watch the sky or not) is the Andromeda galaxy. Easy to locate, it can be seen with the naked eyes on a clear dark night. It is marked as M31 in Andromeda [Devayani]. Look for it between Cassiopeia and Andromeda. To the first time viewers, the galaxy may not appear much of a sight, but remember, this galaxy is very much like our own galaxy, the Milky Way and with some practice you will soon start appreciating its beauty.

Face facing east you can see Taurus, the Bull [Vrishabha] well above the eastern horizon. This constellation has two prominent clusters - Pleiades and Hyades both visible to the naked eyes. Hyades is a 'V shaped cluster with a bright

red star Aldebaran [Rohini] at the tip of one arm of the 'V'. This star, however, does not belong to the Hyades cluster. It just happens to be half way on the line of sight from us and the cluster. Rohini is 4th Nakshatra and Pleiades is 3rd Nakshatra Krittika. A person with good eye sight can count about 6 (or even 7) stars in this group. Use a pair of binoculars to look at this magnificent cluster. This is, however, not a great sight at higher magnification. This group is surrounded by thin dust, which shows up in long exposure photographs.

Now try to identify a chain of stars connecting Pleiades and h & x in Perseus [Yayati] and then try to identify star Algol above this chain. Algol gets its name from its Arabic name Al-Ghul, the Ghost. This star is what astronomers call a variable star. We have given timing of its minima.

To north but slightly below you can see Auriga, the Charioteer [Sarathi] and below and to right is Orion, the Hunter [Mruga] is right above the eastern horizon.

Capella [Brahamha Rhudaya] is the brightest star in Auriga. Under a clear dark night you will be able to make out its yellowish tinge. It is about 45 light years from us.

It is said that to know Orion is to know astronomy. This constellation has almost every type of heavenly objects. It has stars of all the classification; it has dark and bright clouds of gas and dust. This is a good constellation for beginners to start identifying stars in the sky. The basic figure of Orion comes from the three bright stars on a line that is boxed inside four other bright stars. According to the Indian mythology Orion is Mrugha, the Stag. The four stars in the box formation make its front and hind legs and the three stars in middle are the marks of the trident thrown at it by Vyadha, the Killer.

Orion in Greek mythology was the son of Neptune and the Amazon Queen Eurayale. He was an expert hunter and fighter. The three stars in a row make his belt. The stars to left and right make its arms and knees respectively. Chain of stars to the right of the belt is the Sword of Orion. From the latitudes close to the equator such as ours this constellation may not appear as a figure of a giant standing but then turn the map by 90 degrees and the figure will become clear to you.

Orion is to be pronounced as 'or eye on' and not as 'o ri on' as many do. On the map you can see a star marked Betelgeuse [Kakshi]. It is one of the biggest stars knows to us. This ruddy colour star has diameter more than 350 times that of the Sun. This star is what astronomers call red super giant. If it were placed where the Sun is then it would engulf all the solar system up the orbit of Mars. This star is rather a cooler one. Temperature at its surface is about 3500 Kelvin. The surface temperature of the sun is about 6500 K. At the opposite corner of the square is Rigel [Rajanya]. It is the 7th brightest stars in the night sky. Its surface temperature is twice that of the sun about 11000K. The star is about 870 light years from us. It is one of the very bright stars known to astronomers. The star is about 14,000 times brighter than the Sun and its diameter is 35 times bigger. In the sword of Orion lies one of the best nebulas (a cloud of gas and dust in the medium between the stars). It is called the great Orion nebula. In a pair of binocular you can make out a faint bluish glow of this nebula and if you have a small telescope then you can even make out some shape. This nebulosity is about 1,500 light years from us. This nebula takes magnification very will. Bigger the telescope impressive it looks.

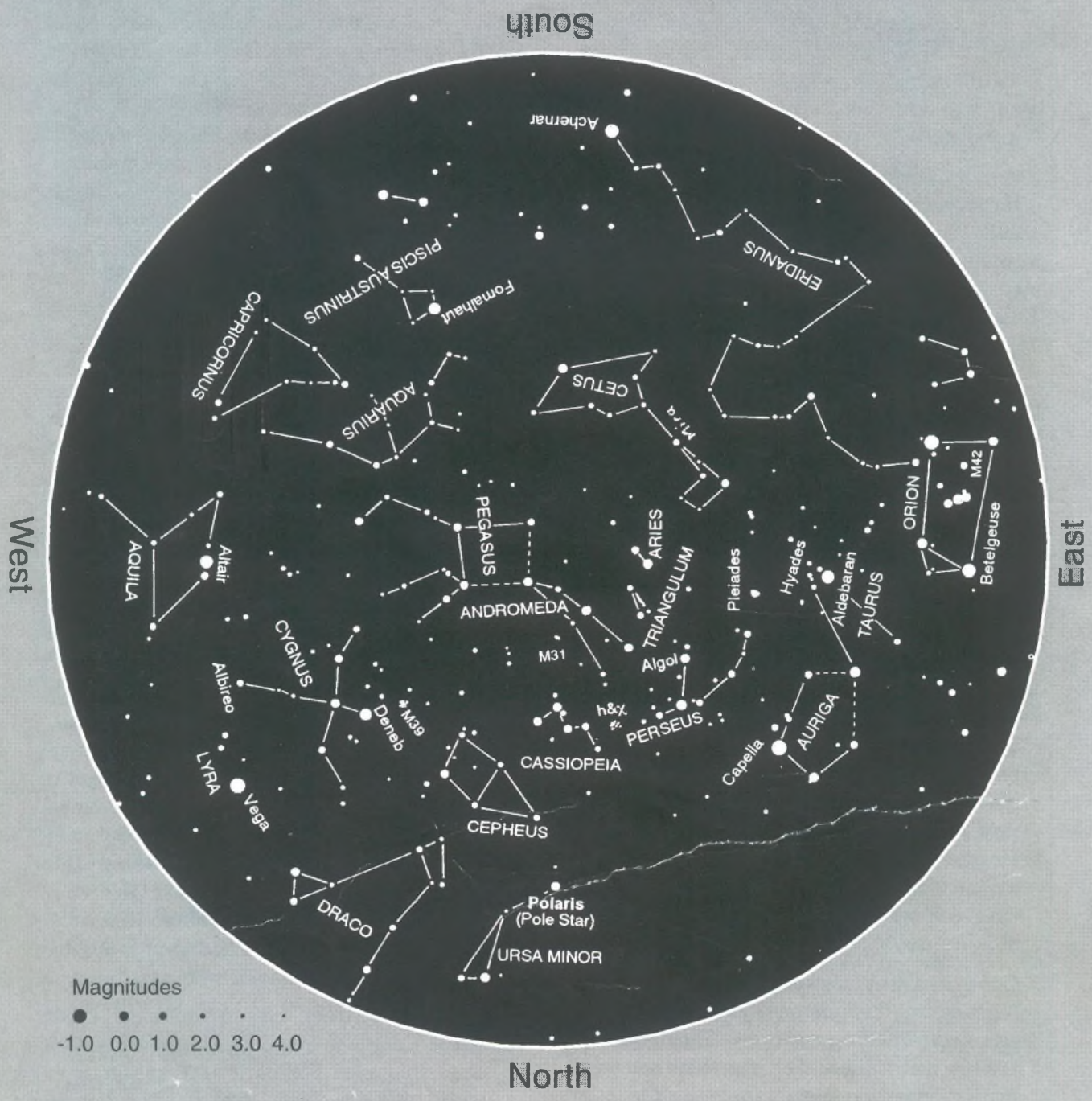
To the left of Betelgeuse and a bit above you should be able to see a group of three stars. It is head of Orion or Mruga Shirsha, the 5th Nakshatra.

Almost overhead but a bit to southwest is Cetus, the Whale [Timingal]. If you look at the map carefully you will find that a star joining two polygons. This star is Mira, the Wonderful. We, in India, tend to pronounce Mira as 'Meera' as in 'Meera-bai'. It is to be pronounced as 'My ra'. This star is a long period eruptive variable. This star is normally too faint to be seen even in a small telescope. But every after 330 days or so this star brightens up which we can see with naked eyes.

By mid December three constellations Canis Major, Canis Minor and Gemini would be well above the eastern horizon. Identify the stars in this region. We will have lot to say about these constellations in the next issue of Akashmitra.

November

Sky at 21:00 hrs IST, on 15th



December

Sky at 21:00 hrs IST, on 15th

Indian Astronomy Olympiad Programme

A BAGFUL OF MEDALS

M. N. Vahia
Tata Institute of Fundamental Research

Aims and Objectives

The Indian Astronomy Olympiad Programme (IAOP) is designed to encourage students with good foundations in Physics and Mathematics and an interest in Astronomy to pursue further studies in this field. In order to achieve this, IAOP organizes nation wide Indian Astronomy Olympiad Tests and about 40 selected students are then invited to the Indian Astronomy Olympiad Camp. The best of the students in the Camp then represent India at the International Astronomy Olympiads.

History

The impetus to the IAOP came from the fact that there is an International Astronomy Olympiad (InO) and Indian participation in the same was considered to be beneficial for popularizing astronomy in India. The InO is an extension of the Astronomy Olympiads that were conducted annually in the former Soviet Union group of countries for the past fifty years. After the disintegration of the Soviet Union, the programme was made international. The first InO was held in 1996 in which no team was sent from India. In 1997, students from City Montessori School, Lucknow participated in the programme and were recognized as the Indian team due to the absence of an official Indian team. Just before the 1998 Olympiad, Dr. Somak Raychaudhari of the Inter University Centre for Astronomy and Astrophysics, Pune who was the coordinator of the Science Popularization Committee of the Astronomical Society of India learnt of the programme and a team consisting of students from Lucknow and Pune was assembled and sent to the InO. Subsequently the Astronomical Society of India at its Annual meeting in 1998 formally adopted the programme and the Indian Space Research Organisation (ISRO) was approached for funding for this Programme. ISRO willingly agreed. In 1999 therefore, under the leadership of Dr. Somak Raychaudhari, two-rounds of tests were organized nationwide to select participants for the Indian Camp. About 35 students were called for the 1st Indian Astronomy Olympiad Camp held in Mumbai. The author co-ordinated the Camp. From the students who participated in the programme, a team of 6 students was selected to represent India in the 3rd InO. This was the first truly Indian Team. The team performed very satisfactorily. The Indian team stood second with 2 Gold medals, 3 silver medals and 1 bronze medal. The same pattern for selection and camp was repeated in the year 2000 for the 2nd Indian Astronomy Olympiad. That year Indian team at InO won 2 Gold and 3 Silver medals and was judged to be the second best team. For the programme for the year 2001, since Dr. Somak Raychaudhari was unavailable, I co-ordinated the entire programme. The selection for the 3rd Indian Astronomy Olympiad Camp was done in February 2001 and 43 students were invited to participate in Camp. That year, at the InO, India won 2 Gold and 2 Silver and 1 Bronze medal.

Selection procedure

The programme is for students of age less than 18 years who are not members of professional Institutions (Universities) when the International Olympiad is conducted in October of the following year. The students are divided into 2 categories: 1) those of age below 16 (Junior Group) and 2) those of age below 18 years (Senior Group). Selection procedure is in three phases, consisting of a qualification round, a selection round that is held nationally and a series of tests conducted during the camp. Nationwide tests are administered on the same day at the same time all over the country.

In the first phase all centres that popularize science and astronomy (a few of the Professional Astronomical Research Institutions, Planetariums and Centres of the National Council of Science Museums as well as some colleges that have envisaged interest in participating in such a programme) are contacted. For the Programme of 2000-2001 scientists from 26 Centres of the National Council of Science Museums, 7 Planetariums, 4 Research Institutions (Indian Institute of Astrophysics, Inter University Centre for Astronomy and Astrophysics, Udaipur Solar Observatory of the Physical Research Laboratory and Tata Institute of Fundamental Research (TIFR)), 2 Colleges and 1 voluntary organization participated in the programmes in different capacities. We have also received request from other organizations to conduct the programme next year. An estimated 3,000 students appeared for the programme in 2000 - 2001. The question papers were prepared centrally at TIFR and sent to all the centres along with the correct answers. This examination is held on 16 December 2001 for the current year.

Each of these centres was then asked to short list 10 students each in both the categories and those centres that had a very large response were allowed to short list 20 students in each categories. 5 weeks

after the first round, on 20 January 2002, the selected students were administered a second and final test. For this, the question papers were designed centrally at TIFR and all the centres returned the answer sheets to TIFR. About 550 answer sheets were received in the current year. These are corrected centrally and about 43 students were selected in the current year to attend the 4th Indian Astronomy Olympiad Camp in May at Nehru Science Centre, Worli, Mumbai from May 14 to 29, 2002.

During the Camp, students are extensively tutored with lectures in Physics and Mathematics as used in Astronomy, taught to analyse astronomical laboratory data and given sessions in sky observations to orient their knowledge to astronomy and astrophysics. Enrichment lectures are also conducted during the camp. Professional college teachers in Physics and Mathematics with an interest in astronomy largely give the lectures and professional astronomers are invited to give lectures on specialized subjects. The students also visit Astronomy Observatories and laboratories. During the camp about 6 tests are conducted. Based on this 3 students in junior category and 2 students in senior category are selected. If any of these are winners of Gold or Silver Medal from the previous International Astronomy Olympiad, additional students can also be taken as per the guidelines of the International Astronomy Olympiad. These students, along with 2 National Representatives, form the Indian Team to the Astronomy Olympiad.

Performance at the International Level

The InO consists of a week long programme organized by the Euro-Asian Astronomical Society of the Russian Academy of Sciences at the site of some astronomical observatory and during the programmes students appear for 3 tests in a) astrophysics b) astronomy data analysis and c) sky observations. Since the Astronomical Society of India took the programme under its purview two years ago, India's performance at the International level has been very satisfactory. India won 3 Gold, 2 Silver and 1 Bronze Medals in 1999; 3 Gold, and 2 Silver Medals in 2000 and 1 Gold, 2 Silver and 1 Bronze medal in 2001. India stood second in both these Olympiads.

Follow up

We have made a compilation of the students who have represented India at the International Astronomy Olympiads since 1997. We have been in e mail contact with most of the students and been forwarding the NASA Space Science News e mail Newsletter to them periodically, apart from keeping them abreast with the developments in the Olympiad activity. We have also offered to give career and other guidance to the students. Two students made extensive use of the information available with us to decide on career (and both decided to pursue a career in Physics). Two students also appeared for other Olympiads in subsequent years and several students who had attended the camp last year also reappeared again in the selection tests to participate in camp held in 2001. We plan to continue to follow the careers of these students and encourage them to undertake summer and other study programmes to keep alive their interest in Astronomy in particular and Science in general. We are also happy that, to the best of our information, none of the students who participated in the programme so far (about 22) have deviated from their studies in science.

Future Vision

If possible, we would like to organize programmes where these students can undertake long visits laboratories where research is done in astronomy and participate in research programmes so that they may be encouraged to pursue a career in Astronomy. A possible offer of job for outstanding students would certainly be very useful. It is also desirable to identify these students as elite or distinguished students and separate workshops and other programmes can also be held for them. Recognition of these students under the Kishore Vaignanik programme, that is done for other Olympiad would also be very useful.

It would also be useful if an intermediate size, fully robotic telescope can be installed in India, which can be used through Internet connection from any place. The approximate cost of setting up such a facility would be of the order of Rs. 0.2 to 1 crore depending on the size of the telescope and quality of other facilities planned. Participation in similar international programmes would also be useful in attracting talented and interested students in Astronomy.

A better publicity for the programme is also very desirable in order to promote the event nationally. Also, funds permitting, the possibility of conducting an International Astronomy Olympiad in India should also be considered. However, this is likely to be expensive since financial support would have to be provided to students from the former Soviet Union group of countries.

Conclusion

The Indian Astronomy Olympiad has been very successful in encouraging students with a good understanding of physics and mathematics and interest in Astronomy to focus their interest and has generated a lot of excitement amongst the student community. It has attempted to maintain a high level of academic excellence, as reflected in the performance of the students at the International level. A follow up of the students shows that they continue to pursue a career in sciences. The programme needs to be expanded. While current level of funding (of the order of Rs. 10 lakhs) is adequate to continue with the present programme, extra funding could be fruitfully utilized to substantially expand the activity.

Does 'night' equal 'day' on Equinox?

Arvind Paranjpye
IUCAA

We have been told a bit too often that on the day of equinoxes, that is on March 21/22 (called vernal or spring equinox) and on September 22/23 (called autumnal or fall equinox) day and night are of equal duration all over the world. Equinox literally means, "equal night".

But is it true really? Check the sunrise and sunset time for your city on 22nd or 23rd of September. You can get this time from your local newspaper. You will find that the day hours are more than night hours. See the table here, which gives sunrise and sunset time for four metropolitan cities of India on 22nd of September 2002.

When I did this exercise many years ago I was surprised. I was in Bangalore then. I then started checking on what date really the day and night are of equal hours, if at all. It came out to be that around 2nd of October night hours equaled day hours. Now the next question was, is the equinox on 2nd of October but celebrated for some historic reason on 23rd of September? So I checked sunset and sunrise time for Pune as well. We used to get Marathi newspaper 'Sakal' by post. It turned out that for Pune the equinox came out to be around 29th of September. Clearly day and night were not of equal duration on the equinox day all over the world at the same time. Yes, there are dates on which day and night were of equal duration of time but those days are different for different cities. What was going on then? Why these dates are called 'equinox'? And this is what I learned : The axis on which the earth rotates is inclined to the plane in which it orbits the sun by 66.5 degrees. As the earth goes round the sun, the angle that its axis makes with the sunrays keeps changing. As a result, some times the area near the north pole is completely basking in the sunlight for all 24 hours (the sun never sets) and at the same time the area near south pole is in complete darkness for days together. Between these two extremes on two occasions sunrays strike perpendicular to the axis of the earth. This suggests that when such an event takes place the day and night should be of equal duration. In other words the sun will be above the horizon for 12 hours and below it for the same duration of time. But we have seen that this does not seem to be happening.

Let us see what exactly happens. The difference comes because of the way "day" hours are calculated and the sunrays are bent as they enter our atmosphere.

The Sun is not a point object in the sky to say that at this instant it is above the horizon and now it is not. The sun has appreciably large size. We see it as a disk. Its average angular size is taken to be about 30 minutes of arc. That is to say that if we measure the angle between two diametrically opposite edges of the sun it will come out to be half a degree.

Now, the time of sunrise is calculated when upper edge (or upper limb as astronomers would like to call it) of the sun is seen just above the horizon. And the day ends at only after the last rays of the Sun disappear below the horizon. There is a further complication due to bending of the sunrays in our atmosphere when it is close to the horizon. Because of this bending, we start seeing the sunrays well before its upper limb is in our geometric line of sight.

Atmospheric refraction of 34 minutes of arc and semi-diameter of 16 minutes of arc tells us that the upper or leading edge of the sun will be 'lifted up'

by about 50 minutes of arc from the true centre of the sun when in geometric or direct line of sight. Sunset is similarly delayed by the same amount of time. Thus, it is not possible to have 'equinox' on a particular day everywhere on the earth.

It is, of course, possible to have day and night of equal duration for some locations on the earth. But on the equator of the earth days are always longer than nights all through the year.

Here are dates of equinox for New Delhi, Kolkata, Mumbai and Chennai. It is indeed a great fun to do the calculations of sunrise and sunset yourself but if you do not feel so much inclined to punch the keys of your calculator, download one of the ephemeredes or planetarium programmes and check out dates of 'equinox' for different latitudes. Check out how sunrise/sunset times are affected at latitudes above 60 degrees. It is very interesting.

We have not dealt with solstices in this article. Think about that too.

Sunrise & Sunset times for September 22, 2002, inIST				
	Sunrise	Sunset	Day hrs	Night hrs
New Delhi	06:09	18:18	12:09	11:51
Kolkata	05:25	17:31	12:08	11:52
Mumbai	06:27	18:35	12:08	11:52
Chennai	05:58	18:05	12:07	11:53

Autumnal Equinox for 2002			
	Date	Sunrise	Sunset
New Delhi	Sept 27	06:12	18:12
Kolkata	Sept 28	05:27	17:27
Mumbai	Sept 29	06:29	18:29
Chennai	Oct 02	05:58	17:58

Put on your thinking caps

'Aadha hai Chandrama Raat Aadhi' is a famous song from V Shantaram's movie Navrang.

Now the question is, can you describe what should be the astronomical situation when the song was being filmed? That is to say at what time of the night (since he says Raat Aadhi) he should be singing the song - what was the Tithi ?

Please send your answer, with explanation.

All correct answers will be acknowledged in the next issue.

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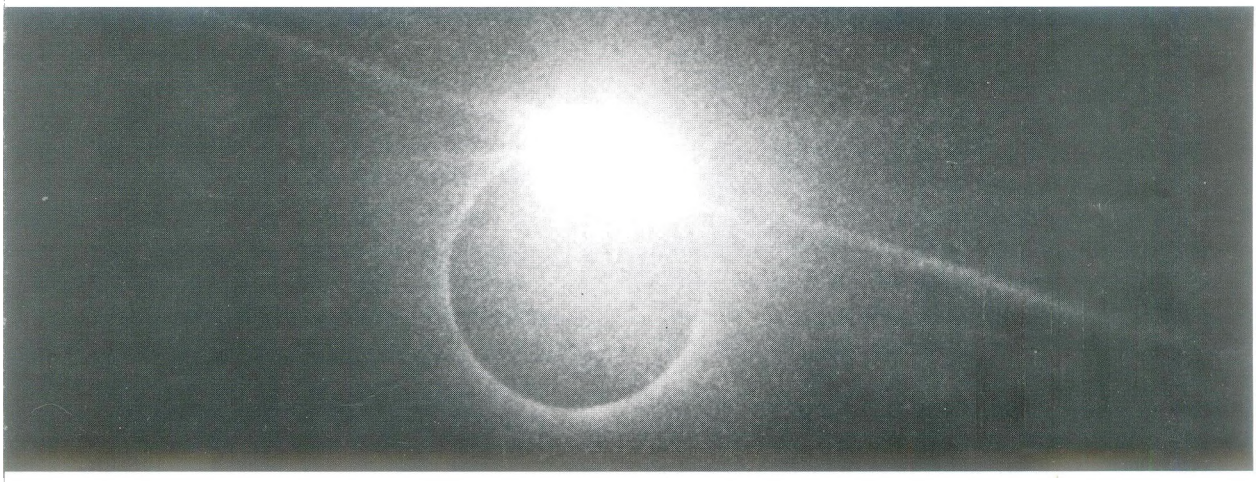
Galore of solar eclipses through Glassy skies

Bharat Adur
Nehru Planetarium, Mumbai

Eclipses here in India have a special meaning; it means some demon is going to swallow our brighter planets. And then there is lots of do and don'ts which one is expected to follow rigorously (or religiously).

After a long gap of 72 years there was to be this eclipse of the century. Preparation for the eclipse was nowhere visible, specially to study the solar corona, it looked more of text bookish eclipse study and not many people to advise how or why not to see this eclipse. Peers and non-peers had their own perception of the eclipse. When the first meeting was conveyed at Amateur Astronomers' Association (Bombay), Xavier's College, Mumbai; there was this air of quite great expectations from this eclipse. The experiments ranged from mythical beliefs to complex problems of how the solar corona.



It all began with writing articles for magazines of how great the eclipse of 1980 are and what to do for the eclipse. Feverish activities began like how to select the site, what are the important events to look forward to for the forthcoming eclipse. Prime institutions in the city were not even gearing themselves to see the event. Under these very conditions effort and individual and at amateur level began, right from selecting the best possible site to view this eclipse to arranging for people to see the eclipse. (No science popularisations awards were there)

The eclipse of 1980 was a bag of personal excitement; curiosity of knowing first hand what is the corona? What are the events associated with the eclipse. Prior to eclipse the recce visit to Karwar was extremely useful to know about the logistics of the place through which the total eclipse would be visible. In this visit there were many things to learn how the locals were totally ignorant of such celestial event.

February 16, 1980 Total Solar Eclipse was the most unforgettable event for several reasons. It brought forth many new issues about the subject. It gave fresh insight into the subject of eclipse, ranging from looking at features of solar corona, and its several manifestations. It also gave a sense of propagation of science as mass education; along with the problems associated with this. Thus began 'eclipse chase' with an ulterior motive to understand the sun and its immediate atmosphere the corona.

The second eclipse in 1981 was to be in Novisbirsk, USSR (now Russia), this was sequel to 1980, the mistakes committed then were verified and improved upon in the colour photography, then emphasis then were on looking for high resolution photography using the colour films. This expedition was along with French astronomers; which gave a new outlook in the French way and style of eclipse observation, which was entirely different then one seen in 80's.

The eclipse bug had bitten now quite hard and there was no looking back, Amateur Astronomers' Association (Bombay) had geared up to take a detail look for the solar corona and this was the

eclipse of over 5 minutes, an expedition was sponsored by the Shipping Corporation of India and many private companies. It was 3 member team, which had successfully observation from Tan jug Kodok in Java peninsula, Indonesia. What was most remarkable was fleeting shadow bands and totality for full five minutes, this was also the first time the shadow band was measured with photodiodes. The results of the solar corona were on colour films; and we were seeing for the first time coronal mass condensates seen around the solar corona. The techniques of eclipse chasing had considerably improved like locating the site on the central line of the totality, camping at site, setting up the joint observation camp along with Indian Institute of Astrophysics, and Physical Research Laboratory, estimating the weather conditions at the suitable sites and planning for logistics.

There was a little lull between 1983 to 1991, as there was regular observations to taken up was Comet Halley Observation Camp (1985-86) from Vangani, which lasted for over two years. This tremendously put faith in the high-resolution work using the colour films.

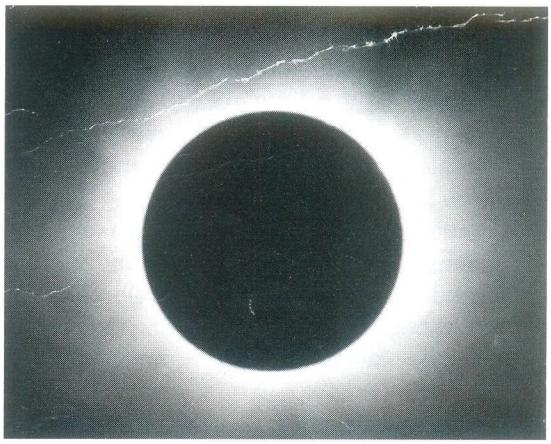
The 1991 eclipse, the longest eclipse of this century; was the next mission to study the solar corona as it lasted for nearly seven minutes. This eclipse was studied from La Paz, Baja California, Mexico. This was the only successfully expedition from India. This eclipse was unique in several ways as the eclipse was seen when the sun was at the zenith, where the air mass was least. Secondly the duration was the longest so one could take longest exposure of the corona extending 10 to 12 times the sun's radii, or more. This expedition was along with the American, German and Latin American astronomers. Here again the experience gained in Indonesia stood the grounds. Having seen now the longest eclipses 'chase' continued with no financial support of peer astronomical or science institutions.

The 1995 Total Solar Eclipse of October had its own connotations and equations laid down by the premier astronomical institutions monopolising the event, and depriving amateur astronomers from funds for conducting the time tested experiments. Here again Amateur Astronomers' Association (Bombay) had set up 3 major observation camps in Bihar, Fathepur in UP, a big camp at Andhyari, in Rajasthan; all these sites were along the central line of this eclipse besides the observations were also done from Mumbai. I had led a team of 3 members from Nehru Planetarium, Mumbai, and was the only team to be on the actual central line as it had been the practice in the past. The observation of the eclipse was extremely good this again reconfirmed the earlier observation of coronal mass condensates. This eclipse had special significance because the site conditions studies were done for full one year ahead. At this eclipse we were able to get Flash spectrum, shadow bands and all one could expect during the totality.

The 1999 Total solar eclipse was the most debated eclipse, this eclipse was to be seen during August (this is monsoon period here), hence Amateur Astronomers' Association (Bombay) prepared to see the eclipse from three different sites, one was to be from Turkey, second was to be from Iran and the third was to be from Bhuj region here. I was leading a team of five members from Mumbai to Esfahan, Iran. The site we had chosen was 30 kilometres south of Esfahan, which was the central line. We had done the regular observations from there along with video recording of the solar eclipse, and polarisation experiment failed. The observations have shown the presence of coronal mass condensates in the solar corona. Turkey observation was successful. Bhuj was overcast during the eclipse.

The Total solar eclipse of 2001 was observed from Lusaka, Zambia at this eclipse there were lesser experiments but finer data reducers and the eclipse was observed for full duration of totality.

Eclipse will continue it is sincere hope and earnest desire that no eclipse is similar or alike every eclipse has its own exquisite beauty, be its location, the local weather or excitement. I am tempted to see some more would you like to join me for this total solar eclipse in 2002.



Jyotirvidya Parisanstha

Established in 1944 Jyotirvidya Parisanstha is the oldest club of amateur astronomers' in India. Its brief history and progress is sketched by **B. D. Limaye.**

The amateur organization called as Jyotirvidya Parisanstha was established in 1944 on Ganesh Chaturthi i.e. the fourth day of the Bhadrapada Month as per Indian Calender, an auspicious day, known as the birthday of Lord Ganesh the god of learning and knowledge. The Society was formally registered in 1945.

Pune is known as a seat of learning and in this city great thinkers like Bal Gangadhar Tilak and Kero Laxman Chattre had sown the seeds for study of astronomy. Hence it was but natural that a pioneering group for study of astronomy be founded in Pune. Eminent persons like Prof M. L. Chandratrey a mathematician, T. G. Dhaole from Meteorological Department, Principal K. R. Kanitkar, J. S. Karandikar of Kesari were amongst the founder members of the Sanstha.

Among the objectives of the Society were :

1) To arrange popular lectures for the diffusion of astronomy knowledge, the chief features being demonstration and observation.
2) To hold discussions on astronomical topics.
3) To collect instruments and other accessories for astronomical observation, measurement, demonstration and instruction.
4) To promote the study of ancient as well as modern works on Astronomy, both practical and theoretical by the institution of study circles.
5) To establish, in the long run an astronomical observatory near Pune and to develop it gradually into an Astronomical Institute.

Shri B. D. Limaye, who retired as a Director Arvi Satellite Centre, Arvi, is a life member of JVP and was its President for a period of few years. At 75 plus today his is still a very active amateur astronomer.

The Sanstha started functioning in right earnest by arranging a series of lectures first on the Solar System. The lectures were delivered in Marathi in keeping with the objectives of the society towards diffusion of knowledge to the people in general. The lectures were delivered by eminent scientific personnel and were later published into a booklet form.

In the subsequent years similar lecture series was arranged on Moon, followed by a booklet. Booklets were also published on various subjects like Time Measurement, Cosmology, Observation Instruments used by the earlier astronomers and their observatories. A set of Star Maps was also published.

The Sanstha regularly publishes a monthly newsletter in which in addition to the ephemeris for major planets, information on important astronomical events recently taken place or predicted are given. Articles on astronomy subjects like biography of an eminent astronomer whose birthday happens to be in the month of publication, or simple explanatory topics also form part of the newsletter.

The sanstha arranges training courses for amateur astronomy enthusiasts. In these courses lasting for a week or more, lectures on co-ordinate systems, sidereal time, local time, standard time, solar system, astro-map reading, types of telescopes their construction etc are given followed by a night star-party where the various

constellations visible at the time are shown with information about the major stars/Messier objects in them. Use is made of a number of telescopes available with the sanstha.

The Sanstha also organizes Star-Parties during the non-monsoon months for its members where they can do their own observations. These parties are usually on a Saturday night near a new moon day. During these parties members are encouraged to bring their own telescopes so that the instruments can be fine-tuned. Star-Parties are also organized for the general public for popularizing Astronomy.

The Sanstha has a good collection of books on Astronomy. It subscribes to magazines like Sky and Telescope. These books and magazines are made available to members for home reading. The collection of books made over last 50 years or so makes it valuable.

The sanstha holds whenever possible lectures by its members as well as by any Astronomer visiting Pune. With the establishment of the Inter-University Center for Astronomy and Astrophysics (IUCAA) in Pune this has become a regular feature. The sanstha had the honour of listening to Dr S. Chandrashekhar, Fred Hoyle and many distinguished persons.

The sanstha had its Golden Jubilee in 1994 when the famous David Malin of Australia gave a lecture in a public auditorium displaying his photographic skills and art. Mr. Malin was very much surprised at the vast gathering and the enthusiasm and curiosity of the people of Pune in a subject like Astronomy.

The Sanstha had arranged for its members special tours during the Solar Eclipses of 1995 and 1999 at places the totality was observable. As a prelude to Total Solar Eclipse the sanstha in association with the IUCAA published booklets containing articles on the phenomenon giving detail data on the places where visibility was possible and also extensive warnings on the damage that can be caused if the eclipse was seen by an unaided eye. Members of the sanstha gave lectures during the pre-eclipse period in several educational institutes about the phenomenon.

The sanstha had also organized Telescope Making Workshops in the city where amateur telescope makers ground their own 6 inch mirrors under the guidance of senior members of the sanstha. Later on mounts for these telescopes were also made available so that the amateurs could enjoy their work actually seeing through the telescope.

The sanstha also organizes exhibitions once a year as a part of popularizing astronomy in which telescopes, models depicting several astronomical phenomena are displayed and explained to the visitors. This aspect has been very popular amongst young and old alike.

The Jyotirvidya Parisanstha has its office at Tilak Smarak Mandir on Tilak Road in the heart of the Pune City. The office remains open on every Sunday between 5:30 p.m. and 8:00 p.m. Tilak Smarak Mandir is a well know landmark of Pune City and is easily accessible.

The postal address of JVP is
Post Box #793, SP college post office, Tilak Road, Pune 411 030, INDIA

Its web URL is :
http://www.jvp.org.in/

One may also contact
Mr Suhas Gurjar who is the President by Tel. (020) 538 1837.

Binoculars

Vinaya Kulkarni
IUCAA

Often amateurs stepping into the field of astronomy question, what type of telescope they should go for and are surprised / disappointed on the advice of buying a good binocular rather than going for a small and cheaper telescope. Using binocular for observations is not too appreciated by the new-comers' community in this field for various reasons. One of such reasons is the fact that whenever observing instruments are discussed among professional as well as amateur observers, most of the times telescopes are discussed. Articles and advertisements on telescopes in astronomical magazines, webresources and any sort of media are more in no. compared to articles on binoculars. This makes mind of a person biased for telescope usage.

Obviously the question arises, "Why binoculars and not a telescope?" Telescope, no doubt, is an important astronomical tool. But moderate binoculars are far better than poor optical quality and bulky telescope. A pair of binoculars is nothing but two small refractors joined together with additional prisms to bend the light rays. This complicates its construction.

A good telescope has been an expensive item. Moderate aperture size (diameter of objective lens in case of refractor and diameter of primary mirror in case of reflector), non-bulky design, smooth motion of axes, good stability makes its price high. Compromise on any of these parameters prohibits its optimal use; and compromise on its optical quality will not give a good image. It is recommended that one should not buy a telescope with an aperture size less than 3 inch in case of refractor and 6 inch in case of reflector. Such a telescope will cost a big amount. In such circumstances you should think of a binocular having a good optics. 7x50 binoculars of a good optical quality will definitely suit your pocket. The good optical quality will ensure good images of celestial objects. But this is not the only reason for which you should go for binoculars.

The other obvious reason is that the observer uses two eyes. It is said, "Our powers of resolution, color perception and detection of image contrast improve dramatically when using both the eyes." One may check this by actually trying out a binocular, first observing with only one eye and closing the other and then observing with both the eyes.

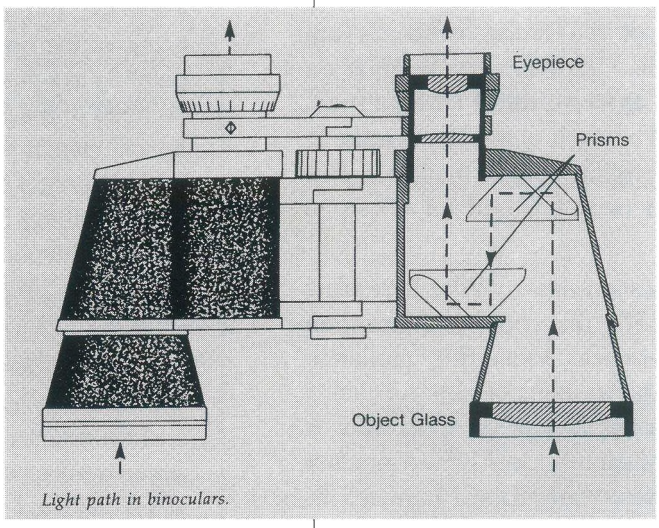
The next practical reason is that a binocular is always portable and handier; not heavy stuff like telescope. You can take them anywhere. Just take it out of the bag, hold it in front of your eyes pointing to celestial objects and that's it. There is no need of assembling the mount or collimating optical elements etc. This gives you chance of exploring night sky very easily when you are on tour or outing in less light-polluted places and thereby your prime aim is not observation.

Once you start using a binocular you will come to know the celestial treasure you can explore with it. Binoculars offer field of view much wider than any astronomical conventional telescope. This enables you to observe extended objects. The white hazy glow of Milky Way looks fabulous when watched through a binocular. You can watch nebulae, galaxies e.g. Andromeda, open clusters like Pleideas, binary stars with the binocular and of course the Moon. The prominent features on Moon surface will be easily seen through any binocular. One can also use a binocular to observe once-a-while guests in our solar system, the comets. Comets, while coming near the Sun become extended objects due to their elongated tails. Wide field instruments like telescope will give view of their central part (coma) and the nearby regions, whereas the binoculars, because of their wide field characteristic will show the tail along with the coma. Believe it's worth watching the comet like Ikeya-Zang with a binocular. After all comets are famous for their tails, isn't it?

Binoculars make it easy to swap or trace the sky or see within the constellations. Binocular is a handy object, one can move it very easily in any direction. It is a very good exercise. If you observe

thoroughly you will get to know the star-spread in the particular region of the sky. This helps while locating or positioning faint and unusual objects with an instrument with smaller field of view and manual positioning system. Thus, it is worth buying a pair of binoculars. One can even use it for terrestrial viewing.

Choosing a pair of binoculars is a bit subjective. Any binocular will do for observing the night sky but some of them will serve you better than others. The price and the company make will help you to choose one. The thumb rule is, 'The relatively high cost and good company make will ensure good optical quality.' But exceptionally, the cheaper one may also be a good piece. It's better to go to the vender and try several ones. Go to the shop late evening and try one by one to view stars. The vendor will explain how to focus it. See which one gives better image. Also see that it is light. It should not be bulky. The binoculars may be big but not bulky. This will make holding and handling the binoculars easier.



Light path in binoculars.

Check for the alignment.
The image from both the sides should be identical. View the object through one eye only and then compare with the image obtained by the other side. If the instrument is not properly aligned the images from both sides will not be exactly same. Don't buy such a piece. One should also try to focus it especially on a star. Focusing other terrestrial objects will not tell you its focusing ability. Some of the binoculars provide a central knob to focus both the sides and some binoculars need to be focused step by step i.e. focus left side first and then the other. This is again going to be a subjective task. It might be difficult to make out exact focus. You may get somewhat focused image with all possible combinations. Try some other binocular and you will find that just one turn is making the image superb. That will be the exact focus. You should go for such a binocular.

A binocular is specified with two numbers separated by a cross e.g. 10X50 or 7X50. The earlier number gives the magnification and the latter gives the aperture size (in cm) of the binocular. A binocular specified as 7X50 magnifies the object 7 times and has its each objective lens of diameter 50 cm. 7X50 binocular is universally recommended. Such a binocular will give adequate magnification, the field is large enough and also light weight to hold thus free from any awkward shake.

Initially hands shake a lot while viewing through a binocular resulting in irritation. Just a minor hand-shake will move the object out of the binocular field. Don't give up the hope. But is just matter of practice. Observing through a binocular is a skill and you will master it after some experience. Once you get used to observing through a binocular the hands will be steadier while observing. Few observers do mount binocular on stand for long time viewing and free from any awkward shake.

Now, you would probably like to know where will you get binoculars? In India, there are very few in the business of astronomical optics and none of them manufacture binoculars but they do sell binoculars. The people in the business of scientific toys and instruments, custom shops will also have binoculars for sale. And if you are fortunate enough you will get a good piece very cheap even in flea market. Just give a hard search.

Wish you dark nights and clear skies for viewing.

Dark Adaptation

Dr. S. B. Kelkar
Dr. N. Timble
Dr. N. Joshi
(Consulting Opthalmologists, NIO)

When we go for stargazing in the night, it is everybody's experience, that it takes about 15 to 20 minutes to get adapted to the darkness. That means after that much time we can see even the faintest objects. We always put red gelatin paper over our torches while reading the star maps. Why is it so?

Here we will discuss how our eyes adapt to the darkness.

Human eye is made up of many layers of issues. Retina, which is the inner most layer of the eye, on which image falls is the most important layer for vision. Retina can be compared with a film of the camera. Photoreceptors are present on retina in the form of rods & cones. Cones are responsible for colour vision and rods are responsible for the black & white vision & dim light vision. Obviously rods are important for stargazing. Rods are present predominantly on peripheral region & cones near the center of retina known as macula. That's why we are able to visualize very dim objects if we look slightly off center.

Rod	Cone
40 to 60 micrometer long	40 to 80 micrometer long
Cylindrical	Conical
Visual purple	Iodopsine

Visual cycle - Photochemistry of retina & metabolism

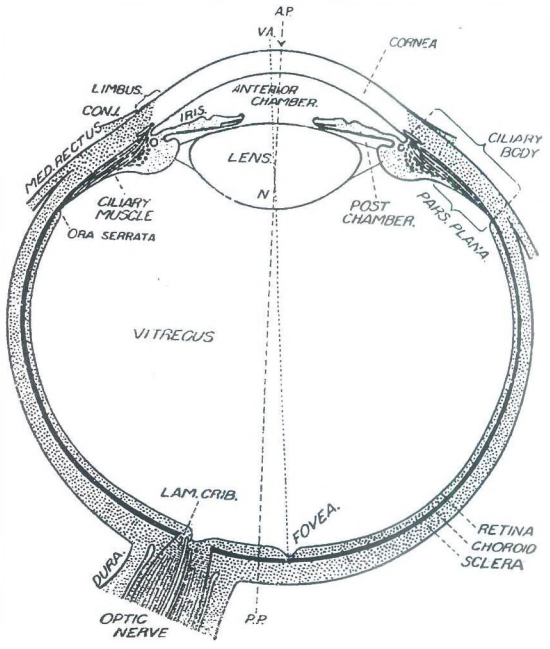
■ Visual excitations is the unique & important function of retina

■ From where the retina gets fuel (energy) to function constantly?

Energy for inner layer of retina is being supplied by glucose and oxygen metabolism from retinal capillaries, whereas photoreceptors receives glucose and oxygen from choriocapillaries of choroid.(layer of the eye outside retina). Waste products of metabolites are carried through same path.

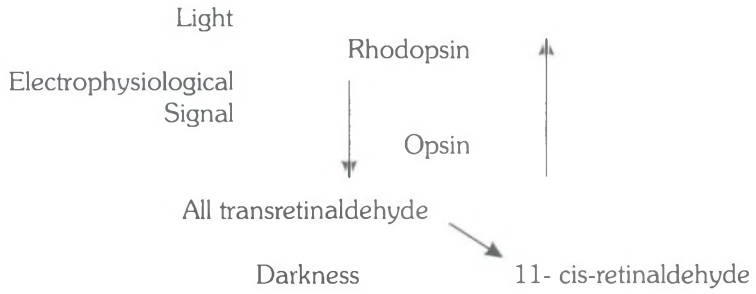
■ Visual Pigments

The visual pigment in rod is rhodopsin and those responsible for colour vision and day light are three types of cone pigments.



Visual Cycle

The cyclic nature of bleaching and regeneration of visual pigments Is termed "Visual cyle" it mainly involves metabolic reaction of vitamin A. Thta is why Vitamin A deficiency causes night blindness.
The visual cycle begins with photoisomerization of 11-cis-retinaldehyde bound to opsin to all trans retinaldehyde; the event that triggers the electro physiological response of the photoreceptors to light.



Mechanisms of visual adaptation

The range of intensity of illumination within which the eye can discriminate changes is from 1 to 1 billion, expressed in logarithmic units range 0 to 9. There are 3 types of sensitivity adjustments that the eye can make. They are :

1 Changes in the size of pupil.

2 Changes in the nerve cells of visual system.

3 Concentration of visual pigments in the retina.

The log unit of pupil size is one whereas that for neural activity is 3 log units and for visual pigment is 8 log units. Everyone is aware that it takes time to get accustomed to the dark. On entering a darkened cinema hall on a bright day , at first one is completely blind, slowly one gets used to the same and is able to identify dimly lit objects. After a good 20 - 30 minutes a person is able to move around with ease. The reverse process is more rapid though initially a person may be dazzled by bright sunlight.

The retina has a dual photoreceptor system one of these is, one which is sensitive at low levels of illumination referred to as scotopic vision and is controlled by rods (pigment rhodopsin) and other is sensitive to day light and is referred to as photopic vision. The dark adapted vision is characterized by an absence of colour perception and low visual acuity and the photopic vision is characterized by increase in temporal spatial acquities and colour perception.

The mechanism of light absorption

The rod's photochemical is made of a derivative of vitamin A plus a protein opsin. Its purple colour gives its name rhodopsin. When light is absorbed, the molecules of rhodopsin change shape and an electrical signal is generated which is converted into a neural signal to be transmitted in the brain. The molecule goes through a series of reactions to finally give back vitamin A and opsin. The chemicals thus become lighter in colour, reflect all wave engths and look white. This is called as bleaching.

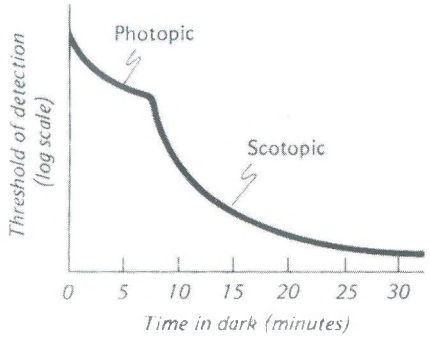
The cells in the retina do not respond immediately to a flash of light, their response does not stop, the instant the flash stops. The first effect is called latency and the second is persistence of response. The intensity of flash affects the latency and persistence periods. The response to a more intense flash is of shorter latency and less persistent.

In the retina as discussed above there are 2 types of photoreceptors. The cones are responsible for colour vision and for visualisation of final details of any object whereas rods are responsible for dark adaptation. Photopic vision is a function of cones and scotopic vision is a function of rods.

The cones are dense in fovea for high resolution and colour vision . As one goes far away from fovea the colour vision fades out. Another factor that plays role is the amount of neural connections. Few cones are connected to one optic nerve fibre whereas a large number rods are connected to one nerve fibre.

Rods are absent from the centre of retina where there are only cones. So in a dark adapted retina the maximal sensitivity for detection of light is in the extrafoveal retina . Hence to detect a dim star at night it should be seen by diverting one's gaze to a point a few degrees to one side of star.

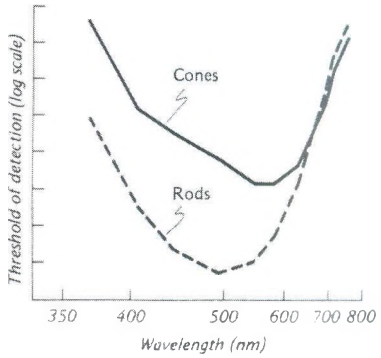
Dark adaptation



If a person is taken from a brightly illuminated environment and put into total darkness, the sensitivity of the individual will begin to recover in a slow and characteristic fashion, a process that is called dark adaptation. If threshold of detection is plotted on vertical axis and time on the horizontal axis, a graph shown in the figure is obtained. In the first 5-10 minutes the cones are operating and so if a light source is used the colour can be perceived later on the rods take over & color perception is lost. Finally after 30 minutes the curve be comes flat.

Why red colour ?

Purkinje shift



There is a change from rod dominated vision to cone dominated vision when the retinal illumination is increased. This is associated with a change in spectral sensitivity of the eye. The wavelength of light at which the eye is maximally sensitive is longer for photopic than for scotopic vision. This shift wherein red appears brighter (longer wavelength) at high light levels to blue appearing brighter at low light levels is called Purkinje shift. This effect is made use of in situations, where rapid changes from scotopic vision to photopic vision is needed. For instance, persons working in dark room such as radiologists, technicians need both photopic and scotopic vision. They prefer prefer to use red goggles or keep a red light in the room. Based on this principle the displays of all telescopes and instruments are usually red in colour, and we use red gelatine paper while reading sky maps.

The adaptation of each eye is independent of other and so each eye can be operated for photopic and scotopic vision.

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QUIZ Ten

1. Which of the following statements is true?

a. The moon orbits around the Earth's center
b. The Earth and the Moon each orbit around a common center
c. The Earth orbits around the Moon's center
d. The Sun and the Moon orbits around the Earth

2. A total eclipse of the Sun by the Moon can only occur when the Moon is?

a. At first quarter
b. When it is full
c. At third quarter
d. At new moon phase
e. Phase of the Moon is irrelevant

3. Which planet was discovered in 1781 by amateur astronomer William Herschel?

a. Pluto
b. Jupiter
c. Uranus
d. Neptune

4. Which is the largest planet in our solar system?

a. Jupiter.
b. Ceres
c. The sun
d. Earth

5. A solid body from space that lands on earth is called a...?

a. Meteorite
b. Shooting star
c. Meteoroid
d. Meteor

6. Which is the closest star to the Sun?

a. Alpha Centauri
b. Sirius
c. Vega
d. Proxima Centauri

7. What does "escape velocity" describe?

a. The velocity with which light enters a black hole
b. The velocity needed for a body to break free from another's gravity.
c. The velocity a comet needs to maintain an orbit around the sun.
d. The speed a moon must travel to orbit a planet.

8. Which of the following planets does not have rings system?

a. Uranus.
b. Venus.
c. Saturn
d. Jupiter

9. In general, comets are composed of...?

a. Ice and dust particles.
b. Molten rock.
c. Solid rock, like an asteroid.
d. There is no particular composition of a comet defined

10. The average distance between the earth and sun is not?

a. 149.6 million kilometers.
b. 1 light year.
c. 1 Astronomical Units (AU).
d. 8.2 light minutes

Send your answers to editor@akashmitra.com

Answers in next issue

Can you identify the faintest star ?

Constellation of Orion

Photograph by - Dr. Vishwanath Jigjinni

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